STATE OF OHIO
Richard F. Celeste, Governor
DEPARTMENT OF NATURAL RESOURCES
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DIVISION OF GEOLOGICAL SURVEY
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Report of Investigations No. 139

GLACIAL GEOLOGY OF MAHONING COUNTY, OHIO

by

Stanley M. Totten
and
George W. White

Columbus
1987

ODNR
OHIO DEPARTMENT OF NATURAL RESOURCES

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Editor's note: It is fitting that in the year of our 150th anniversary we bring to a close the contributions of the late George W. White. This report on the glacial geology of Mahoning County is the final Division of Geological Survey publication authored by Dr. White.

Photocopy composer: Jean M. Lesher
Cartographer: James A. Brown

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GLACIAL GEOLOGY OF MAHONING COUNTY, OHIO

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ABSTRACT

Mahoning County, Ohio, is located within the glaciated portion of the Allegheny Plateau. The land surface is a weakly to moderately dissected plain sloping northward toward Lake Erie. Elevations range from 1,000 feet in the northern part of the county, where local relief is 20 to 30 feet, to over 1,200 feet in the south, where local relief is considerably greater. Mahoning County is located within the Ohio River drainage basin; the master stream is the Mahoning River, which nearly encircles the county.

Glaciation in Mahoning County resulted from southward expansion of ice in the Grand River sublobe of the Erie lobe. Several ice sheets invaded the county during the Wisconsinan Stage, and an unknown number of advances occurred in earlier Pleistocene time. Wisconsinan drift is present at the surface over all of Mahoning County, and pre-Wisconsinan tills occur in the subsurface. Intensely weathered Slippery Rock Till, regarded as pre-Illinoian in age, occurs in buried valleys exposed by strip mining. Sandy, crumbly Mapledale Till of probable Illinoian age also is exposed in strip mines beneath Wisconsinan-age Titusville Till. Mapledale Till is characterized by a high proportion of fragments of local bedrock and is represented by two till units separated by thin sand or gravel.

Titusville Till of probable Early Wisconsinan (Altonian) age occurs over the entire county but is buried beneath younger deposits. Titusville Till typically is dense, sandy, and stony and oxidizes to a distinctive olive brown. Titusville Till is considerably thicker than other tills and makes up the bulk of the glacial deposits in the Allegheny Plateau. In most sections the Titusville Till rests directly on bedrock which has been glacially eroded. The Titusville Till is a complex stratigraphic unit consisting of as many as five subunits in places separated by thin layers of sand or sandy gravel.

Kent Till, the oldest Woodfordian (Late Wisconsinan) till, overlies Titusville Till and is generally present over the entire county. Kent Till averages 5.3 feet thick and is exposed at the surface only in the extreme southeastern corner of the county. Kent Till is silty, sandy, loose, and friable; it contains many small pebbles and some cobbles. Kent Till oxidizes to a distinct yellow brown.

Lavery Till of Woodfordian age overlies Kent Till and is the surface till over the eastern and southern parts of Mahoning County. Lavery Till has an average thickness of 5.5 feet but tends to be thin and discontinuous near its boundary in southeastern Mahoning County. Lavery Till is predominantly silty and sparingly pebbly and oxidizes to a dark chocolate brown.

Hiram Till of Woodfordian age is the youngest till in Mahoning County and overlies Lavery Till. Hiram Till occurs at the surface in two sublobes in western and west-central Mahoning County. Its average thickness is 5.6 feet. Hiram Till is very clayey and very sparingly pebbly and oxidizes to a dark chocolate brown similar to Lavery Till.

Large tracts of hummocky topography occur over about half of Mahoning County, mainly in the south. As many as 12 morainic elements can be delineated in the west-central part of the county. The end moraines consist of relatively short ridgelike segments and low hummocks several feet to as many as 30 feet high. Much of the hummocky topography is included in the Kent Moraine.

Kame terraces occur along one or both sides of the valleys of Middle Fork Little Beaver Creek and its East Branch, Cherry Valley Run, the Mahoning River, Crab Creek, Meander Creek, Mill Creek, Garfield Ditch, Honey Creek, Yellow Creek, and North Fork Little Beaver Creek. Extensive valley-train remnants are preserved as terraces along the valley sides of the Mahoning River, Mill Creek, Honey Creek, Naylor Ditch, and Middle Fork Little Beaver Creek.

Sand and gravel deposits occur in many places in Mahoning County. The most evident large supplies of sand and gravel are in the kame terraces in the larger valleys. Most of the sand and gravel deposits are of Titusville age and in most places have a covering of till which may reach many feet in thickness.

Glacial sands and gravels are important aquifers where they have sufficient extent and thickness. Areas with the greatest potential yield of ground water are the glaciofluvial deposits in the preglacial and interglacial drainage channels in the county.

INTRODUCTION

Mahoning County is located in northeastern Ohio (fig. 1) in the glaciated portion of the Allegheny Plateau (fig. 2). The county is bounded on the north by Trumbull County, on the west by Portage and Stark Counties, on the south by Columbiana County, and on the east by the state of Pennsylvania. Mahoning County lies between 80°31′ and 81°05′ west longitude and 40°54′ and 41°08′ north latitude and covers an area of 422 square miles.

The county seat and largest city is Youngstown, the center of a highly industrialized complex located along the Mahoning River and extending for 25 miles or more from Warren in Trumbull County to Lowellville on the state line. According to the Federal Census, the population of the county in 1980 was 289,487, a decrease of 5 percent from 1970. The 1980 census population for Youngstown, not including suburbs, was 115,427, a decrease of 17 percent since 1970. Other municipalities in Mahoning County include Boardman, Austintown, Struthers, Campbell, Canfield, Sebring, and Poland. All but Sebring are located within the Youngstown urban complex.

The urban and industrial development of Youngstown and Mahoning County has resulted in acquisition and conversion of large acreages of land from agricultural use to urban use such as homes, factories, shopping centers, schools, and highways. In addition to the loss of agricultural land, natural resources such as coal, clay, limestone, sand, and gravel, which are obtained mainly by surface mining, may no longer be accessible because of construction on or near the mineral deposits or because of zoning restrictions in urban areas.

PURPOSE AND SCOPE

This report describes the glacial drift—the surface material overlying the bedrock—in Mahoning County (pl. 1). Stratigraphy of the deposits and morphology of the landforms are described and correlated with deposits and morphologic features of bordering counties. Economic resources of the glacial drift are considered, and suggestions are made for resource utilization and conservation.

This report will be of interest to various groups and individuals: geologists, highway engineers, construction firms, sand and gravel pit operators, architects, city planners, soil scientists, and landowners. Citizens who are

FIGURE 1.—Location of Mahoning County, Ohio.

or will be responsible for planning and shaping the future of Mahoning County for agriculture, urbanization, recreation, and industrialization will find this report useful in making their decisions.

PREVIOUS INVESTIGATIONS

The first report specifically on the geology of Mahoning County was by Newberry in 1878 and dealt mainly with bedrock, including the economic beds of coal and limestone. Newberry did mention (p. 781-782) the general prevalence throughout the county of "a sheet of Drift material," which seemed "to have been produced by the southern extension of a tongue or lobe of the great glacier, which, moving from the north, excavated the low country that lies between the highlands of Geauga and Portage [Counties] on the west, and those of Pennsylvania on the east." He noted that "glacial marks" were present on "the exposed surfaces of the harder rocks in nearly all parts of the county," and that their direction was "nearly north and south."

In his great monograph, Leverett (1902) included Mahoning County on his map (pl. 15) of the Grand River lobe. He showed the eastern and southeastern part of the county as occupied by "moraines" and mentioned this area in his text (p. 438, 451). This area is that of the Kent Moraine. Leverett apparently included some kame-terrace areas with his "moraine." He reported the thickness of drift in the county ranged from "slight" to as much as 190 feet (p. 461-462).

White's (1951, pl. 1) reconnaissance study of the southern part of the Grand River lobe included the southern part of Mahoning County. Investigations of the glacial deposits of adjacent Stark County (White, 1963), Portage County (Winslow and White, 1966), Trumbull County (White, 1971a), and Columbiana County (White and Totten, 1985) have contributed to the present study of Mahoning County. Investigations (Shepps and others, 1959; White, Totten, and Gross, 1969) to the east in adjacent Pennsylvania extended into Mahoning County. Mahoning County was included in summary maps and reports on the glacial geology of the Allegheny Plateau (White, 1969) and of northeastern Ohio (White, 1982). Very early drift deposits in a buried valley near Youngstown have been described by Totten, Moran, and Gross (1969). Divisions of the Titusville Till in Mahoning County have been described by Moran (1967, 1971). The differences in grain size and in feldspar percentage among tills of the Allegheny Plateau, including Mahoning County, were described and analyzed by trend-surface methods by Gross and Moran (1971). The ground-water resources of Mahoning County are shown on a map by Crowell (1979).

The soils of Mahoning County have been studied by Lessig and others (1971), and their maps show in great detail the various soils, which are indicators of the kind of drift at the surface. The soil survey contains excellent discussions of the relation of glacial materials to soil types.

ACKNOWLEDGMENTS

This report is an outgrowth of an investigation by George W. White of the glacial geology and water resources of northeastern Ohio; this investigation was sponsored by the U.S. Geological Survey in cooperation with the Ohio Department of Natural Resources, Division of Water. Study of the petrography of the tills and of the stratigraphy of the older tills was supported by grants from the National Science Foundation and the University of Illinois Research Board. Generous sharing by Heber Lessig in office conferences, in correspondence, and in field conferences of his intimate knowledge of the soils and the geological controls is gratefully acknowledged. David L. Gross and Stephen R. Moran assisted in the field in 1965, when the stratigraphy of older tills was investigated. Helpful information was given by William A. Rice and Robert G. Wiese, Jr. of Mt. Union College, by William Lewis of the Mahoning County

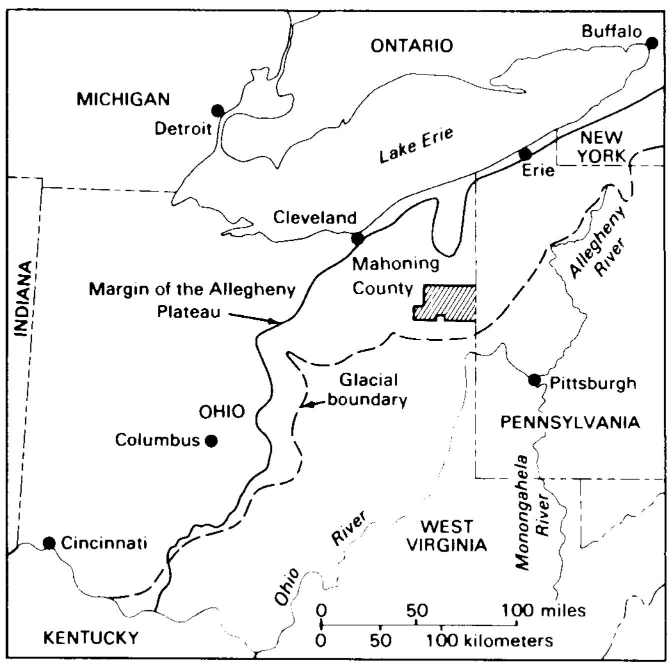


FIGURE 2.—Location of margin of Allegheny Plateau and glacial boundary in Ohio and Pennsylvania and position of Mahoning County (modified from White, 1969, fig. 1).

Planning Commission, and by William Fergus of the Eastgate Development and Transportation Agency. The area was restudied and earlier maps were revised by both authors during the 1973 field season.

PHYSIOGRAPHY AND TOPOGRAPHY

Mahoning County is located entirely within the Glaciated Allegheny Plateau section of the Appalachian Plateaus physiographic province of Fenneman (1928, 1938). The land surface is a weakly to moderately dissected plain sloping northward toward Lake Erie. In the northern and western portions of the county, elevations commonly are between 1,000 and 1,100 feet, and the local relief is low, rarely exceeding 20 or 30 feet. In the southern and eastern portions of the county, local relief is considerably greater, and many of the hilltops exceed 1,200 feet in elevation. The highest point in Mahoning County, a hilltop located in secs. 27 and 28, Green Township, 2 miles northwest of Washingtonville, has an elevation of 1,314 feet, nearly 300 feet higher than the nearby valley of Middle Fork Little Beaver Creek. The lowest point is where the Mahoning River leaves the county near Lowellville at an elevation of 800 feet.

In general, the modern topography is smoother than the preglacial topography, although the topographic differences brought about by glaciation may not be as great as in Stark County (White, 1963). Many preglacial and/or interglacial stream channels have been partially or wholly filled, and bedrock hills have been smoothed by ice abrasion.

A prominent topographic feature of Mahoning County is smoothed, oval to nearly circular bedrock hills generally ½ to 1 mile in diameter and 50 to 150 feet high. Most of the hills are streamlined and elongate in a north-south direction; they resemble drumlins, but, unlike drumlins, are composed of bedrock. These hills owe their resistance and possibly their distribution to Pennsylvanian-age sandstone units.

Conspicuous accordant summit levels, called peneplains, have been described from Columbiana County by Stout and Lamborn (1924, p. 38-43). The highest well-developed upland level, known as the Harrisburg peneplain, formerly extended over Columbiana and adjacent counties at an elevation of about 1,270 feet (Stout and Lamborn, 1924, p. 38). Several hills in southern Mahoning County appear to be remnants of the Harrisburg surface. Below the Harrisburg peneplain, a less well developed erosion level at about 1,120 to 1,140 feet was identified as the Worthington peneplain (Stout and Lamborn, 1924, p. 40). Valleys as much as a mile wide were cut 100 to 150 feet below the Worthington level (Stout and Lamborn, 1924, p. 41-43). These wide valleys were interpreted as the Parker Strath, an incomplete peneplain. It is probable that the wide Mahoning River valley near Alliance (Stark County) is a Parker Strath level.

MODERN DRAINAGE

Mahoning County is located within the Ohio River drainage basin. The drainage lines of the county exhibit a curious tangled system of valleys unlike most other natural systems. The master stream of the county is the Mahoning River, which nearly encircles the county. The Mahoning River heads in Columbiana County, flows northward through Alliance, in Stark County, and has been dammed to form Berlin Reservoir and Lake Milton near the western border of Mahoning County. Near Warren, in Trumbull County, the Mahoning River bends sharply southeastward and transects northeastern Mahoning County, where the river has become central to the Youngstown industrial complex. The course of the Mahoning River from Warren past Youngstown to its junction with the Shenango River to form the Beaver River near Newcastle, Pennsylvania, is a large, deep, linear trench, unlike any other valley in the county.

Other drainage lines in Mahoning County are influenced by a divide trending east-west from New Middletown to Sebring across southern Mahoning County. Six streams—Honey Creek, North Fork Little Beaver Creek, East Branch Little Beaver Creek, Cherry Valley Run, Naylor Ditch, and an unnamed stream just west of Beloit—all flow south from this divide. Middle Fork Little Beaver Creek flows north from Columbiana County west of Salem, forms a loop in south-central Mahoning County, then flows southward back into Columbiana County east of Salem. Three streams—Mill Creek (west)[1], Yellow Creek, and the Mahoning River—flow north through the divide.

The Mahoning River is not the only stream to exhibit drainage peculiarities, nor does it carry all of the drainage from the county. The extreme northeastern part of the county is drained by a tributary of the Shenango River, Little Deer Creek, which flows northeastward to Sharon, Pennsylvania. Most southward drainage reaches the Ohio River by way of Little Beaver Creek.

The major drainage lines in the county have a strong north-south linear trend or lineation, a trend which parallels the bedrock hills. The linear trench of the Mahoning River at Youngstown has a northwest-southeast trend. This secondary trend is mirrored by many of the smaller streams such as Honey Creek and tributaries to Mill Creek (east) and Meander Creek. Both the north-south and northwest-southeast trends most likely are bedrock-controlled because the affected streams are independent of glacial morphology, till character, and till thickness.

EARLY DRAINAGE SYSTEMS

The advent of glaciation in northeastern Ohio during the Pleistocene Epoch profoundly disrupted drainage by damming streams, filling valleys with drift, and diverting waters into other drainage basins. Each glacial advance led to new diversions, and the modern drainage is a composite of the successive diversions.

The sequence of drainage changes for Mahoning County and adjacent counties has been discussed in great detail by several authors (Stout and Lamborn, 1924; Stout, Ver Steeg, and Lamb, 1943; Coffey, 1914, 1930, 1958, 1961); only a general summary will be given here.

At the onset of the Pleistocene, at the time the wide Parker Strath valleys had been cut, a very early divide passed east-west across the northern part of Columbiana County, so that the major streams draining Mahoning County flowed north. The preglacial drainage almost certainly followed several of the present-day drainage lines northward toward the Erie basin. Stout, Ver Steeg, and Lamb (1943) show three major preglacial streams draining northeastern Ohio: the Ravenna River, Geneva Creek, and the Pittsburgh River.

[1]There are two streams named Mill Creek in Mahoning County. The Mill Creek in western Mahoning County has headwaters in the vicinity of Bunker Hill and Boyds Corners and flows north and west into Berlin Reservoir; this stream is denoted as "Mill Creek (west)" throughout the text. The second Mill Creek flows north through central-eastern Mahoning County from the Mahoning-Columbiana County line near Columbiana to the Mahoning River at Youngstown; this stream is denoted as "Mill Creek (east)" throughout the text.

With the first advance of an ice sheet into northeastern Ohio in Nebraskan(?) or Kansan(?) time, northward drainage was ponded, and preglacial valleys and their tributaries were at least partially filled with drift. Ponded waters were backed up into their headwaters by the damming effect of ice until water overflowed the divides, cutting notches or cols in several places through the divides. For the southward-flowing streams mentioned previously, the diversion became permanent; the other streams resumed northward flow in somewhat modified valleys.

Several drainage modifications are of particular note. The Mahoning River was diverted southwestward at Warren, and the river has cut a trench following the upstream course of a preglacial tributary. The Mahoning trench apparently was cut to its greatest depth during the Deep-Stage cycle of valley cutting, and the modern stream flows in a partially drift-filled valley. It is curious that the Mahoning River did not establish a channel through the upland south of Alliance, although water certainly backed up into the headwaters several times.

Three moderate-sized valleys have drainage divides created by glacial drift within their confines. These drift divides occur near Garfield, just south of Calla, and northeast of New Albany. Near New Albany, Goodman Ditch, a tributary of Meander Creek, is a wide abandoned portion of the Middle Fork Little Beaver Creek valley. This wide valley probably was occupied, and thus preserved, by an ice block that diverted drainage both north and south. Meander Creek heads in the moraine near Patmos, meanders eastward around and between drift knolls for 4 miles, is joined by Goodman Ditch in the preglacial valley, and follows a northerly course into Trumbull County.

Cherry Valley Run, which heads in the wide part of the valley at Calla, flows southward in a narrow valley constricted first by bedrock hills and then by kames. North of the divide at Calla and in the same valley, Indian Run travels northward a short distance to the south edge of Canfield, where the stream has been diverted eastward to Mill Creek (east) by way of a narrow gorge of its own cutting. Middle Fork Little Beaver Creek follows an irregular twisting path northward past Salem to Hickory Corners, where drift fills the valley, blocking northward flow into Meander Creek. At Hickory Corners, Middle Fork bends east and then south and flows into a wide preglacial valley choked with drift at both ends. Middle Fork has cut a narrow outlet through the kames at Millville to flow into Columbiana County, where the stream has been diverted to the south through an upland.

Mill Creek (east) originates south of Columbiana in Columbiana County and flows northward into Mahoning County in a narrow valley constricted with drift. Four miles north of the Columbiana-Mahoning County line, the valley broadens remarkably to a width of 1 mile and becomes swampy. The wide valley extends northward 7 miles to Youngstown, where Mill Creek has cut a winding gorge 150 feet or more deep and 4 miles long through bedrock.

BEDROCK GEOLOGY

The bedrock of Mahoning County, first described in a general way by Newberry (1878), is composed of essentially flat-lying strata of Mississippian and Pennsylvanian ages. The bedrock is mantled everywhere by glacial drift, and natural exposures are limited to stream valleys and steep hillsides where the overlying drift has been eroded. Extensive strip mining and road construction have provided excellent manmade exposures of both drift and bedrock.

The oldest exposed bedrock in the county is the Mississippian-age Cuyahoga Formation (Newberry, 1878, p. 783). This formation, which consists of shale and sandstone, crops out in only two places in the county: in the extreme north-central portion and near drainage in the Mahoning River valley and its tributaries in the vicinity of Youngstown (Sedam, 1973). Rau (1969) mentions that the Mississippian strata dip to the south at approximately 12 feet per mile.

Pennsylvanian-age rocks of the Pottsville and Allegheny Groups are present over the remainder of the county; these strata are of considerable interest because of valuable resources of coal, clay, limestone, and sandstone. Some iron ore was mined in early days (Newberry, 1878, p. 790). The strata containing the resources commonly are so closely spaced vertically that two or even three commodities may be stripped in the same mine. The Pottsville Group is the surface bedrock in the northern and central portions of the county and crops out in the deeper valleys in the south. The Allegheny Group is the surface bedrock in the southern portion of the county and on the higher uplands of the central part.

GLACIAL GEOMORPHIC FEATURES

Many of the surface features of Mahoning County owe their formation directly or indirectly to glaciation. These features, which include ground moraine, end moraine, lake plain, and glaciofluvial landforms, are the products of several ice advances. It is convenient to discuss these constructional geomorphic features separately from the stratigraphy of the deposits (discussed on p. 18) because many landforms did not result from deposition by the last glacier to cover the region, but are the result of deposition and modification by multiple glaciations.

GROUND MORAINE

Ground moraine has a relatively smooth or gently rolling surface that lacks the notable knolls and hummocks which characterize end-moraine topography. Nearly half of Mahoning County is covered by ground moraine (pl. 1). Ground-moraine topography is produced primarily by the glacial deposition of thin till sheets or layers which either mantle bedrock hills or extend over broad, nearly featureless areas known as till plains. Thus the ground-moraine surface may or may not reflect the underlying bedrock surface.

Several large tracts of ground moraine cover the northern part of Mahoning County, whereas more numerous but smaller tracts of ground moraine occur in the southern part of the county (pl. 1). The largest tract, 100 square miles or more in area, of ground moraine extends from Youngstown west to Lake Milton and Berlin Reservoir. Except for several valleys and small patches of hummocky topography, this tract has 20 feet or less of relief in a mile. This tract of ground moraine can be traced northward into Trumbull County, where it becomes the till plain of White (1971a). A tract of ground moraine of about 20 square miles in Smith Township in the southwestern corner of the county is generally flat to broadly or gently rolling, and much of the surface is poorly drained. Over much of this area northeast of Alliance, bedrock is within 8 to 12 feet of the surface, and much of the topography reflects the bedrock surface mantled with a thin veneer of drift.

The ground-moraine surface in central, southern, and eastern Mahoning County is largely a reflection of the bedrock surface. The till is generally quite thin in these areas, except in the valleys and morainic belts, and bedrock is exposed in many places on steep slopes. In these areas, which are too numerous, diverse, and complex to be described individually or in detail, the ground moraine occurs in two distinct topographic situations: (1) along the flanks of steep-walled valleys such as the Mahoning River gorge and Middle Fork Little Beaver Creek, and (2) on the crests of bedrock hills.

END MORAINE

End moraines are more or less continuous hummocky ridges of till deposited at or near the ice margin wherever it fluctuated over a narrow belt for a period of time. These moraines commonly are well drained relative to the surrounding areas. A series of end moraines sweeps across Ohio in a general east-west direction, bending south into the major drainage basins to define the Miami, Scioto, Killbuck, and Grand River lobes (Goldthwait, White, and Forsyth, 1961). In the Allegheny Plateau of northeastern Ohio, including Mahoning County, the moraines are less ridgelike and tend to be discontinuous. Belts of east-west-trending hummocky topography are present in Mahoning County, but these belts cannot be traced across the entire county, nor can they be correlated with the named moraines to the west in the Killbuck lobe (White, 1982). Typically the end moraines consist of relatively short ridgelike segments and low hummocks several feet to as much as 30 feet high.

End-moraine segments and associated hummocky topography in southern Mahoning County have been grouped into a broad end-moraine complex known as the Kent Moraine (White, 1982). The Kent Moraine was named by Shepps and others (1959) for a wide band of hummocky topography which in a general way marked the margin of the Kent Till in northwestern Pennsylvania. Thus the Kent Moraine represents the same hummocky belt referred to as the "main morainic system" of the Grand River lobe by Leverett (1902) and earlier workers.

In the Grand River lobe the Kent Moraine may be divided into two parts: (1) a major more or less continuous tract of hummocky topography in northern Columbiana County (White and Totten, 1985) and (2) a discontinuous tract of hummocky topography in southern, central, and southeastern Mahoning County (pl. 1). Within the discontinuous tract in Mahoning County, individual end-moraine segments reach lengths of 6 miles or more; the width of each segment generally is less than 1 mile except where two or more segments coalesce. These morainic segments are most nearly continuous in the west-central part of the county west of Middle Fork Little Beaver Creek. In this area as many as 12 distinct morainic elements can be delineated and the northern portion of the Kent Moraine attains a maximum width of about 13 miles. The most prominent end-moraine segment occurs near Patmos in Goshen Township, 5 miles northeast of Damascus. This belt is best developed along Calla Road for a distance of 4 miles on each side of Patmos. A somewhat less prominent end-moraine segment 2 miles south of Patmos trends east-west from east of Pointview to Goshen Center and East Goshen, and ends north of Sebring. The valley of Garfield Ditch cuts through this segment. North of Patmos, additional morainic segments occur along Western Reserve Road and Berlin Station Road.

These end-moraine segments or belts are thought to represent ice-marginal positions, though not necessarily of the latest ice sheet. The east-west-trending belts do not follow either the Hiram or Lavery Till margin (pl. 1) but are more nearly parallel to the Titusville and Kent boundaries to the south in Columbiana County (White and Totten, 1985). White, Totten, and Gross (1969) demonstrated that the wide Kent Moraine in northwestern Pennsylvania actually is composed of the earlier Titusville drift and is veneered with a thin layer of Kent Till. A similar stratigraphic relationship exists in Mahoning County, where the Kent Moraine is composed largely of Titusville drift veneered with Kent Till and in places also by thin Lavery and Hiram Tills.

Gravelly kames are so common in the Kent Moraine in northeastern Ohio (White, 1982) that it is known as a kame moraine. Most of the gravel within the Kent Moraine in Mahoning County is associated with kames and kame terraces in the larger valleys. Gravel is exposed in these areas either in excavations or in road cuts where the till cover over the gravel is thin; in many places the till cover is thicker and the presence of gravel can only be confirmed by deeper borings and well records. Some of these hummocky areas may be buried kames and kame terraces with a covering of later drift, and some areas are only gravelly till or till containing small pockets of gravel. These gravelly areas are shown by overprint on plate 1.

OTHER HUMMOCKY TOPOGRAPHY

Several tracts of hummocky topography in the northern part of Mahoning County (pl. 1) are not included in the Kent Moraine. A few hummocky tracts are associated with valleys, and the valley topography evidently exerted control on ice-sheet deposition. However, some well-developed hummocky tracts occur on uplands between the Kent Moraine to the south and the Defiance Moraine to the north in Trumbull County (White, 1971a). One large hummocky tract occurs south and east of Lake Milton in Milton and Berlin Townships (pl. 1). Within this tract are two east-west-trending elements which separate Lake Milton from Berlin Reservoir. Hummocky tracts in northeastern Mahoning County have mainly a northwest-southeast trend closely parallel to the trend of the Mahoning River gorge. Hummocky-moraine elements as much as 1 mile wide and 5 miles long occur on both sides of the Mahoning River valley. It is possible that the unnamed hummocky-moraine elements in northwestern and northeastern Mahoning County are poorly developed or poorly preserved remnants of end moraines which are correlative with the more continuous named end moraines in the Killbuck lobe. These unnamed hummocky tracts in Mahoning County are similar to the Kent Moraine in topographic appearance and in composition. The hummocks consist primarily of Titusville Till covered with a thin veneer of younger till. Gravelly areas within the hummocky tracts are shown by overprint on plate 1.

GLACIOFLUVIAL LANDFORMS

Sorted and stratified sand and gravel deposited by meltwater streams flowing on, within, beneath, and beyond a glacier are classified under the broad heading of glaciofluvial deposits. Glaciofluvial deposits give rise to landforms with characteristic features that distinguish them from other glacial landforms. The glaciofluvial landforms in Mahoning County are kames, kame terraces, and valley trains. In many cases, these landforms have been modified and wholly or partly obscured by overriding ice. Many of the original meltwater landforms are veneered with one or more tills, and their original topographic expression has been subdued.

KAMES

Kames are conical hills or mounds of poorly sorted sand

and gravel formed when the material was washed into holes in the ice or into reentrants along the margin of the melting ice. Further melting of the ice resulted in slumping of the material and development of collapse bedding structures.

Most of the kames in Mahoning County occur in valleys and are discussed below with kame terraces. A few kames are grouped in two upland areas, one east of Lake Milton, the other north of Columbiana.

The kames 2½ miles west of Lake Milton occur along a narrow north-south-trending belt about 2 miles long. The kames are broad, gently sloping hummocks that project inconspicuously 10 to 15 feet above their surroundings. Tributaries of Duck Creek nearly surround individual kames.

The other kame area is concentrated in sec. 29, Beaver Township, 3 miles northwest of Columbiana. This kame complex rises as much as 50 feet above its surroundings and ranks as the most prominent glacially deposited feature in Mahoning County. The surface is very hummocky; Midway Church and cemetery are located on the highest part. Ohio Route 14 crosses the kames east of the church and Ohio Route 11 slices through the kames west of the church. A half mile to the south is a small isolated kame about 20 feet high juxtaposed with a drift-covered bedrock knob.

KAME TERRACES

Kame terraces consist of sand and gravel deposited by meltwater flowing along valley sides between the valley walls and stagnating ice masses which remained in the valley after the main mass of ice had melted from the uplands. Upon melting of the ice masses, hummocky deposits resembling kames or valley trains remained along the valley sides, and in many places kettle holes remained in the valley. Kame terraces may exhibit all gradations of morphology from high-level valley-train segments to groups or chains of kames and kame deltas.

Kame terraces occur in several valleys in Mahoning County (pl. 1). Many of these kame terraces have been overridden by later ice sheets that deposited till over the terraces, partially altering their topography. Where the till covering is thick, the exact limits of the terrace deposits are not discernible.

Middle Fork Little Beaver Creek valley

The terraces in the Middle Fork Little Beaver Creek valley are complex in age and distribution. The valley is formed by two branches that join north of New Albany. These two branches are partially choked by kames more isolated than connected. Southward from the junction of the two branches narrow terrace segments are present along both valley sides for 3 miles past New Albany to the county line. These low-level terraces have an elevation of 1,060 feet near New Albany and a southward gradient of about 5 feet per mile. In the vicinity of Millville, the valley is completely filled with terrace gravels except for the narrow gorgelike channel of Middle Fork. East of Millville the terrace is nearly ½ mile wide and has two distinct levels, both of which are higher than the New Albany terrace. The upper bumpy, irregular terrace has an elevation of about 1,120 feet and the lower smoother level has an elevation between 1,080 and 1,090 feet. Both levels apparently head near Millville and extend east-southeast for 4 miles to Washingtonville, at the Columbiana-Mahoning County line. The valley west of Washingtonville south of the county line is completely plugged with drift, and drainage has been diverted southward through the upland between Washingtonville and Salem. A lake formed in the valley north of Millville during final ice retreat, and as water overflowed the gravel barrier a narrow channel was cut through the barrier, draining the lake.

Cherry Valley Run valley

Narrow but nearly continuous kame terraces on both sides of Cherry Valley Run valley extend from Calla southward to Washingtonville and Leetonia, in Columbiana County. In places the terraces are covered and partially obscured by till. Kames at an elevation of 1,160 to 1,170 feet plug the valley at Calla and mark the drainage divide between the southward-flowing Cherry Valley Run and northward-flowing Indian Run. The terraces slope southward at about 20 feet per mile. A small tributary terrace joins Cherry Valley Run 1 mile north of Washingtonville.

Mahoning River valley

The Mahoning River valley near Youngstown contains remnants of one or more kame terraces which largely have been covered and obliterated by industrial and urban construction. The best preserved portion of the terrace is at Lowellville, where the terrace is present on both sides of the valley. The terrace is more extensive on the north side of the valley, where it is about 2 miles long, 600 feet wide, and attains an elevation of 900 to 940 feet. The terrace on the south side is very narrow and not quite as long.

Crab Creek valley

A broad kame terrace occurs on the east side of the valley of Crab Creek, a tributary of the Mahoning River in Youngstown. The terrace extends northeastward along an unnamed tributary. The Crab Creek terrace is about ½ mile wide, 2 miles long, and has an elevation of 900 feet. The tributary terrace is narrower and reaches elevations of more than 1,000 feet.

Mill Creek (east) valley

The kame terraces in the valley of Mill Creek probably formed in two or more stages when the drainage was southward (present drainage is northward from the Columbiana-Mahoning County line to Youngstown). At the county line 1 mile north of Columbiana the valley is nearly choked with drift, mainly in the form of kames, which reach elevations between 1,090 and 1,100 feet. Three miles farther north at East Lewistown the kame terrace has an elevation of 1,070 to 1,080 feet. North of East Lewistown, the terrace is narrow and practically disappears except for a tributary valley near New Buffalo, which is nearly filled with kames for 2 miles upstream.

Garfield Ditch/Mill Creek (west) valley

The valley in Goshen Township occupied by Garfield Ditch and Mill Creek has a prominent kame terrace along the west side of the valley and a remnant on the east side in its northern reach. Kames which reach an elevation of 1,110 feet choke the valley in the vicinity of Boyds Corners. Toward the south the terrace has an elevation of 1,120 to 1,140 feet and slopes southward.

Other kame terraces

A kame terrace about 3 miles long occurs along North

Fork Little Beaver Creek and its tributaries near New Springfield. The terrace, partially destroyed by strip mining, heads in a kame complex (shown as gravelly moraine on pl. 1) south of the Ohio Turnpike at an elevation of about 1,200 feet and slopes 40 feet per mile southeastward to the county line.

A kame terrace in the valley of Honey Creek, in the southeastern corner of the county, has been largely obliterated by strip mining. The terrace heads near New Middletown and extends southeastward into Pennsylvania. The most extensive terrace remnant is north of Petersburg, where the valley is nearly filled with kames. A small terrace 2 miles long heads near New Middletown in Harman Run, a tributary to Honey Creek.

Two irregular tracts of kame terrace are located in the valley of Yellow Creek in Springfield Township. One tract is at the south edge of Pine Lake at an elevation of 1,100 feet. A second tract is near the spillway at the north end of Evans Lake at an elevation of 1,050 to 1,100 feet.

VALLEY TRAINS

Large volumes of sediment-laden meltwater flowed southward and southeastward down several major valleys in Mahoning County as the glaciers melted. The sorting action of meltwater streams caused the silt and clay to be carried farther down the valleys, but the outwash sand and gravel were not carried far and were deposited in the valleys as valley trains. In the northward-sloping valleys, the outwash ponded until water overflowed the divides, and the valley trains in these valleys merge with lake plain. Postglacial erosion removed much of these valley trains; their remnants, where present, are terraces along valley sides. Valley-train terraces resemble, and may be mistaken for, kame terraces. The latter generally may be distinguished by their position farther up the valley sides, by a more hummocky surface, and by a more irregular inner margin.

Mahoning River valley, Youngstown area

Along the Mahoning River valley, remnants of an extensive valley train are preserved in the center of Youngstown and downstream on either side of the valley. Most of the terrace is obscured by extensive building on it. The least disturbed portion of the valley train is on the north side of the river at Lowellville. At this location, at least two and possibly three separate terrace levels can be recognized. Typically each street or railroad in Lowellville that parallels the river is located on a terrace, the lower ones on valley-train terraces, the upper ones on kame terraces.

Mill Creek (east) valley

A valley train 1 mile wide and 7 miles long is present in Mill Creek (east) valley. The valley train is nearly featureless, poorly drained, and pitted with several small kettle holes and one large depression. The valley train has a slight slope toward the north, from an elevation of 1,020 feet in the south to 1,010 feet in the north.

Honey Creek valley

The valley train of Honey Creek is nearly ½ mile wide in the widest part and about 4 miles long. This valley train extends into Columbiana County. Its upper part is at an elevation of 1,140 feet and the lower part has an elevation of 1,050 feet for a gradient of 20 feet per mile. Several short tributaries from the north add to the width of the train.

Mahoning River valley, Alliance area

A very broad valley train is present in the Mahoning River valley in southwestern Smith Township east of Alliance. The valley train, more nearly an outwash plain, is about 2½ miles wide, and its surface ranges in elevation from 1,050 to 1,075 feet. Because no passage for meltwater to flow south existed below 1,100 feet, it is clear that meltwater ponded below this level. However, drainage was sufficient for the deposition of sandy gravel over a wide area. A similar though smaller valley train is present in the small unnamed tributary southeast of Sebring.

Naylor Ditch valley

A broad valley train nearly a mile wide is located southwest of Garfield in the valley occupied by Naylor Ditch. This valley train, which is not much longer than it is wide, is pitted with several small kettle holes, and drainage is poor. Several small valley-train segments north of Garfield are at a slightly lower elevation and seem to be related to the northward-flowing drainage.

Other valley trains

Several small terrace remnants are present in the valley of Meander Creek south of Meander Creek Reservoir. These terrace remnants may represent either ponded outwash resulting from glacial ice damming the northward-sloping valley, or an alluvial floodplain level developed by postglacial runoff shortly after the disappearance of glacial ice from Mahoning County.

A few small valley-train segments remain in the valley of Middle Fork Little Beaver Creek. Most of these segments are in the vicinity of New Albany.

LAKE PLAIN

Lake plain refers to an area which received sediment while it was covered by a body of standing water. Such areas have different degrees of flatness depending upon the duration of the lake, the amount of sediment deposited, and the relief of the surface on which the lacustrine material was deposited. Many shallow proglacial lakes must have existed principally in northward-sloping valleys during each of the glacial stages when ice covered the northern part of Mahoning County. Most of these lakes left very little evidence in the way of sediment, or else the evidence was buried by later ice advances. The areas of lake plain shown on plate 1 were differentiated from valley trains by the occurrence of lacustrine silt, clay, and peat at the surface.

Three large areas and many small areas of lake plain are present in Mahoning County. One plain of nearly 1,000 acres occurs northwest of Sebring in a broad depression now drained by Fish Creek. A second plain occurs in a kettle hole which occupied an abandoned portion of the valley of Middle Fork Little Beaver Creek now occupied by Callahan Ditch in secs. 9 and 16, Green Township, northeast of Salem. The third area is a nearly filled kettle hole in Mill Creek (east) valley in Beaver Township northwest of North Lima.

PLEISTOCENE STRATIGRAPHY

As previously noted, the glacial deposits of Ohio are a result of several ice advances during the Pleistocene Epoch. Ice accumulated far to the northeast in eastern Canada in the general area of Labrador and spread out laterally in all directions. A portion of this ice advanced southwestward into the Erie basin as a major tongue known as the Erie lobe. As the Erie lobe advanced into northern Ohio, it spread southward into lowlands and subdivided, from east to west, into the Grand River, Killbuck, Scioto, and Miami lobes. Glaciation of Mahoning County resulted from a general southward expansion of the Grand River lobe. Figure 3 shows the margin of the various tills in the three lobes in northeastern Ohio and the relation of the tills and their boundaries in Mahoning County to those in nearby areas.

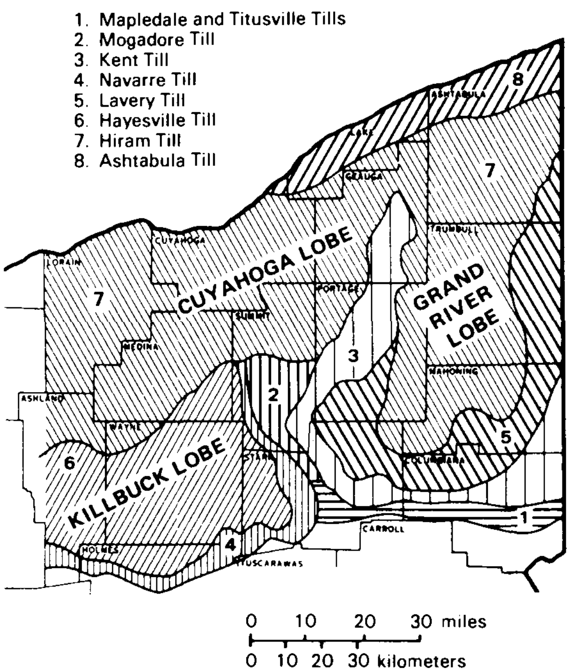


FIGURE 3.—Glacial lobes and tills in northeastern Ohio.

CLASSIFICATION

Four major glacial stages of the Pleistocene Epoch, separated by warmer interglacial intervals, are generally recognized in the central United States:

Wisconsinan Stage
Sangamonian Interglacial Stage
Illinoian Stage
Yarmouthian Interglacial Stage
Kansan Stage
Aftonian Interglacial Stage
Nebraskan Stage

Ice moved into Mahoning County several times during the Illinoian and the Wisconsinan glacial stages and probably advanced into the county during one or both of the earlier glacial stages. Conclusive proof of the age of older deposits in the form of direct interregional correlation is not possible because nearly all the older deposits have been removed by erosion.

As ice moved over Mahoning County it deposited till—an unsorted, unstratified mixture of clay, silt, sand, and gravel. Meltwater flowing on, within, beneath, and away from the ice deposited outwash—sorted and stratified sand and gravel. Deposits of silt and clay accumulated in glacial lakes. A thin and discontinuous deposit of windblown fine sand and silt, called loess, mantled the slopes and uplands after ice retreat. During periods of ice retreat (interglacials or the briefer interstadials), the climate ameliorated, vegetation flourished, the deposits weathered, and soils were formed.

Each major ice advance into northern Ohio carried material of slightly different texture and composition from that of the preceding advance. It is possible therefore to differentiate tills and to trace them for several thousands of square miles through parts of several counties in Ohio and adjacent Pennsylvania. These tills are rock-stratigraphic units or formations and are assigned names for purposes of mapping and discussion (table 1).

CRITERIA FOR IDENTIFYING AND CORRELATING TILLS

Identification and correlation of tills are based upon field criteria and laboratory analyses. Factors considered are (1) weathering characteristics, (2) texture, (3) mineral composition, (4) color, (5) structure, (6) topography and drainage, and (7) areal and stratigraphic position of the till with respect to other tills.

WEATHERING CHARACTERISTICS

The weathering of till produces a soil profile that may be subdivided vertically into several horizons (White, 1963, 1967).

Horizon 5 is the unaltered till, which is some shade of dark gray. This horizon is typically 10 to 15 feet below the surface; many exposures are too shallow to reveal gray till.

Horizon 4 is calcareous till, which differs from horizon 5 in that the gray till has been oxidized to a shade of brown that is different for each till. The oxidized color is a useful field-identification criterion. Veins of gray secondary carbonate enrichment are found in some places in the upper part of this horizon.

Horizon 3 is composed of brown till from which the carbonate minerals have been leached by the percolation of ground water. Dark rusty-brown and black stains of iron and manganese oxides may be present along joint and fracture surfaces, particularly in the sandy tills. The contact between horizons 3 and 4 is known as the depth of leaching, which ranges from as little as 2 feet below the surface in the youngest tills to over 12 feet in the oldest tills. This depth, which is easily determined in the field by use of dilute hydrochloric acid, is an aid in distinguishing different tills. The depth of leaching is dependent on many variables, including age of the till, topography, drainage, and parent material. Within a single till sheet of sufficient thickness these variables are at a minimum, and depth-of-leaching measurements are generally consistent enough to be of value.

One of the biggest problems concerning the depth of leaching, and one that is commonly overlooked, is correct interpretation of leaching depths when till sheets are thin and discontinuous. Depth-of-leaching values may be significant only for till deposited by the last ice sheet to cover a particular area and then only if the till is sufficiently thick that leaching has not proceeded into or has not been influenced by material underlying the till. There are many places in Mahoning County where an older till is at or near the surface in an area of a younger till. In some places the

TABLE 1.—*Glacial stages and deposits in Mahoning County*

Epoch	Stage	Substage	Unit or interval	Deposit in Mahoning County	Approximate dates (years B.P.)
PLEISTOCENE	Wisconsinan		Late-glacial and postglacial	alluvium, peat, loess, lacustrine silt and clay	Present
		Woodfordian	Hiram Till	dark-brown clayey till	15,000
			ice retreat	loess(?), sand(?)	16,000
			Lavery Till	dark-brown silty till	16,500
			ice retreat	loess(?)	17,500
			Kent Till	yellow-brown sandy till	19,000
		Farmdalian	ice retreat	paleosol	24,000
		Altonian	Titusville Till (several units)	olive-brown sandy till	28,000
	Sangamonian		prolonged ice retreat	paleosol	75,000(?)
	Illinoian		Mapledale Till (two units)	silty, sandy till	(?)
	Pre-Illinoian		prolonged ice retreat	loess, alluvium, paleosol	
			Slippery Rock Till?	deeply weathered till	

older till has been partially eroded, exposing fresh calcareous till. In such places the amount of leaching of the older till cannot be expected to be greater than the amount of leaching of the till deposited by the last ice advance.

Horizon 2 is composed of thoroughly weathered till in which some pebbles and cobbles have decomposed. Clay coatings are present, as well as dark stains of iron and manganese oxides along joints in many places.

Horizon 1 is the soil of soil scientists, and generally is divisible into an upper gray-brown to dark-brown topsoil (A) and a lower yellow-brown subsoil (B).

Different tills give rise to different soil types (table 2; Lessig and others, 1971). In addition to the length of time a till has been weathered, till texture and mineralogy also influence soil types.

TEXTURE

The texture or size of the grains composing a till has been an important criterion in till identification in northeastern Ohio and northwestern Pennsylvania (Shepps and others, 1959; White, 1963, 1967; White, Totten, and Gross, 1969). Texture for Mahoning County tills was determined by using Shepps' (1953) method of size analysis and was calculated as percentages of sand, silt, and clay. Textural data are shown in table 3 and in several illustrated sections (figs. 4, 6, 9).

MINERAL COMPOSITION

Tills in Mahoning County consist of a large variety of minerals, the most abundant of which are quartz, feldspar, clay minerals (illite, chlorite, kaolinite), and carbonate minerals (calcite, dolomite). Studies of till samples from northeastern Ohio, including Mahoning County (Totten,

TABLE 2.—*Major soil associations of Mahoning County and their parent materials*

Soil association	Parent material
Canfield-Ravenna-Wooster	Kent Till
Rittman-Wadsworth-Frenchtown	Lavery Till
Mahoning-Ellsworth-Trumbull	Hiram Till
Geeburg-Remsen-Trumbull	Hiram Till
Loudonville-Muskingum-Dekalb	thin till over rock
Bogart-Chili-Jimtown	outwash sand and gravel
Sebring-Fitchville	lake silts and clays
Wayland-Orrville	floodplain clay, silt, sand, and gravel

TABLE 3.—*Average composition of tills in Mahoning County and the Allegheny Plateau*

Till	Mahoning County			Allegheny Plateau[1]				
	Sand (percent)	Silt (percent)	Clay (percent)	Sand (percent)	Silt (percent)	Clay (percent)	Total feldspar (percent)	Potassium feldspar (percent)
Hiram	10	48	42	20	45	35	27	44
Lavery	33	41	26	30	45	25	21	45
Kent	45	38	17	41	41	18	17	49
Titusville	43	38	19	45	37	18	13	50

[1]Plateau data from Gross and Moran (1971).

1960; Heath, 1963; Totten, Moran, and Gross, 1969; Gross and Moran, 1971), and from northwestern Pennsylvania (Gross, 1967; White, Totten, and Gross, 1969) indicate that individual tills differ in mineral content.

COLOR

The color of a till is a subtle but very useful physical characteristic in till identification. With practice and experience, these subtle color differences can be distinguished by use of the standard Munsell Soil Color Charts (1954). All tills, where sufficiently thick, display two dominant colors: gray where unaltered and brown where oxidized; the color change in Mahoning County is commonly 8 to 12 feet below the surface. The original gray color is due primarily to ferrous iron; oxidation to ferric iron gives the till a brown color, the shade of which is characteristic and consistent for each till.

STRUCTURE

Structure refers to the size and shape of the individual pieces that result when till fractures or breaks. Unweathered till commonly appears structureless, but weathered till may exhibit a variety of fracture patterns. It is not known how these patterns are produced, but they are of use in distinguishing tills.

TOPOGRAPHY AND DRAINAGE

The surfaces of different till sheets in many cases show differences in topography and drainage that aid in distinguishing one till from another. These differences may be detected in the field, but they are most evident on aerial photographs. These differences are relative and must be considered with care. In general, slopes tend to become smoothed and rounded with increasing age, and drainage becomes more extensive and integrated.

AREAL AND STRATIGRAPHIC POSITION

The approximate areal and stratigraphic positions of the tills in neighboring areas show that the older tills generally extend farther toward the glacial boundary than the younger tills (White, 1963; Winslow and White, 1966; White, Totten, and Gross, 1969). Stratigraphic sections showing more than one till are of importance in determining the sequence of deposits, and the relative age relationships between tills in a sequence may be inferred by intercalated paleosols and other deposits. Numerous multiple-till stratigraphic sections have been studied in Mahoning County (Moran, 1967; Totten, Moran, and Gross, 1969) and a number of sections are illustrated in this report.

PRE-WISCONSINAN DEPOSITS

Wisconsinan drift is present at the surface over all of Mahoning County (pl. 1); therefore, earlier drift is exposed only in stream cuts or excavations. Studies in northwestern Pennsylvania (White, Totten, and Gross, 1969) and northeastern Ohio (Moran, 1967; Totten, Moran, and Gross, 1969) have revealed the presence of several drift units beneath Early Wisconsinan drift. Pre-Wisconsinan drift is known from several localities in Mahoning County.

PRE-ILLINOIAN DEPOSITS—SLIPPERY ROCK TILL

Intensely weathered till exposed beneath unweathered Mapledale Till in a quarry near Slippery Rock in northwestern Pennsylvania has been named the Slippery Rock Till (White, Totten, and Gross, 1969). Similar weathered till has been recorded from several other localities in northwestern Pennsylvania.

In Mahoning County, intensely weathered till similar to the Slippery Rock Till is present in three buried valleys near New Springfield and New Middletown (Totten, Moran, and Gross, 1969) (figs. 4, 5). This weathered drift represents the oldest Pleistocene material yet discovered in Mahoning County. Because comparison with the Slippery Rock Till is based on weathering characteristics and not on lithology, this correlation must remain tentative.

The age of the Slippery Rock Till has not been determined with certainty. The weathering characteristics of the till indicate it is older than Mapledale Till (see below) and therefore probably pre-Illinoian (Nebraskan or Kansan).

ILLINOIAN DEPOSITS—MAPLEDALE TILL

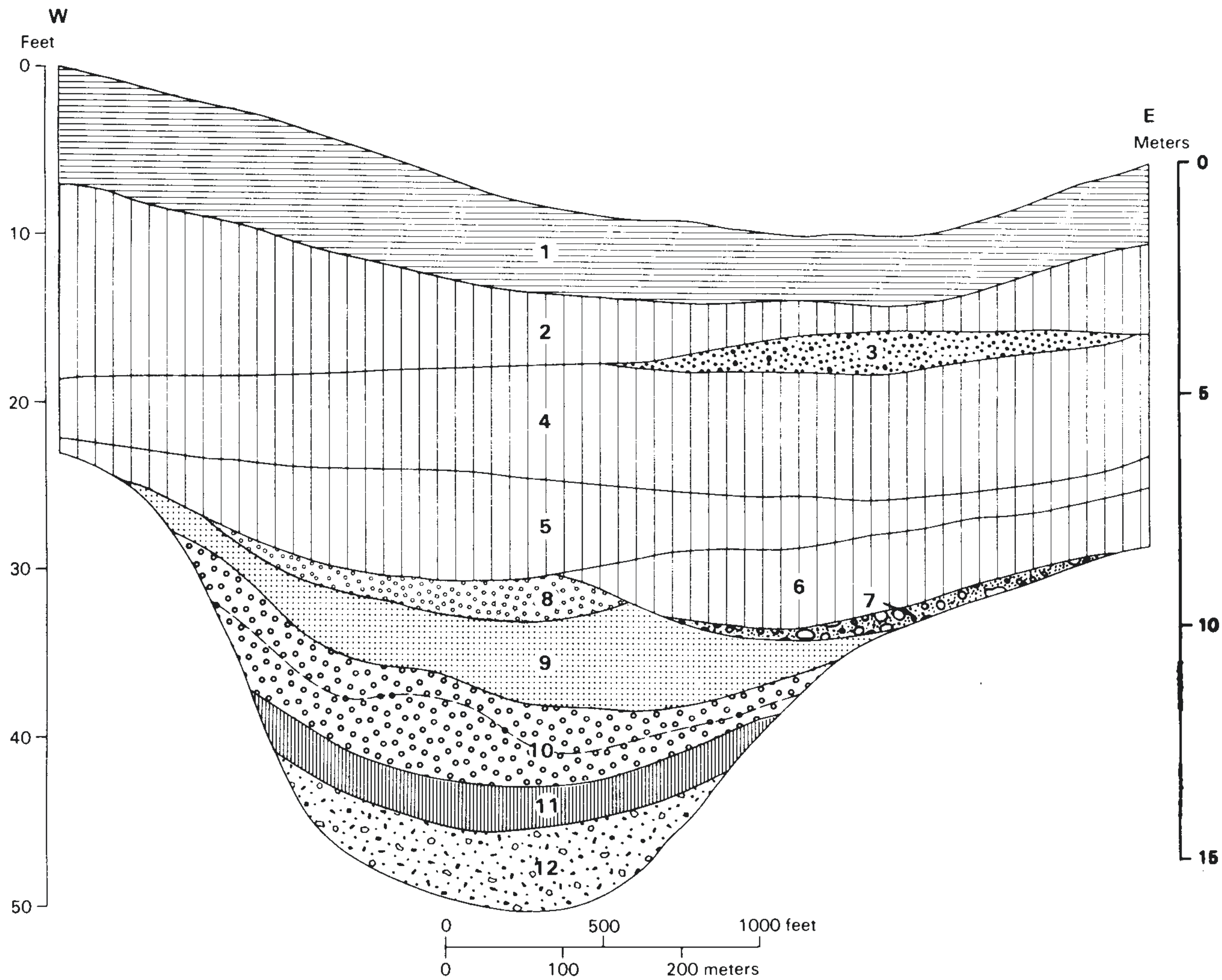
The Mapledale Till is named (White, Totten, and Gross, 1969, p. 15) for exposures at Mapledale, a suburb of Franklin in northwestern Pennsylvania. The Mapledale Till in Pennsylvania, formerly referred to as "outer phase Illinoian" (Shepps and others, 1959, p. 20), is characterized by a high proportion of bedrock fragments.

Mapledale Till is exposed in at least three strip mines in Mahoning County. Near Beloit about 20 feet of loose crumbly sandy gray Mapledale Till underlies Titusville Till (fig. 6). Only a thin sandy zone separates the Mapledale and Titusville Tills in this section. The Mapledale Till is separable into two units by a line of boulders. The till rests on the side and shoulder of a resistant bedrock hill located within the wide preglacial Mahoning River valley.

North of Damascus a small valley in shale contains 7 feet of gray Mapledale Till (fig. 7). The till appears to be unweathered, although the upper part is noncalcareous. The gravel in the bottom of the valley is older than Mapledale Till, and may be related to the stream that formed the valley. Two units of gray Mapledale Till separated by 4 feet of gravel are exposed in a strip mine near Petersburg.

SANGAMONIAN INTERGLACIAL STAGE

The disappearance of the Illinoian ice was followed by the Sangamonian Interglacial Stage, which lasted at least several tens of thousands of years. During the warmer climate of the Sangamonian Stage, valleys were cut or deepened, and soils were formed. The subsequent Wisconsinan ice advances removed nearly all of the Sangamonian soil so that in only a few places is any evidence of weathering preserved.



1. Till, yellow-brown, pebbly, crumbly, sandy; weathered in upper part; lower 1 foot calcareous; 39 percent sand, 14 percent clay. KENT
2. Till, olive-brown, stony, rusty, calcareous; pebble zone at base; 34 percent sand, 20 percent clay. TITUSVILLE II
3. Sand and gravel, lenticular
4. Till, olive-brown, very stony, very hard, calcareous; olive gray in lower part, rusty along joints; 32 percent sand, 18 percent clay. TITUSVILLE III
5. Till, drab-olive-gray, calcareous, stony; sand lens at top; sand, gravel, and cobbles at base; 31 percent sand, 26 percent clay. TITUSVILLE IV
6. Till, olive-gray, calcareous, stony. TITUSVILLE V
7. Sand and gravel, gray, calcareous
8. Gravel and sand, greenish-gray, noncalcareous
9. Silt, dark-gray, sandy, hard
10. Gravel, greenish-gray; pebbles rotten and crumbly; thin peat layers; separated into two parts by gray silt layer
11. Till, drab-olive to yellow-brown, pebbly, silty, clayey, noncalcareous; pebbles soft and weathered; 28 percent sand, 34 percent clay. SLIPPERY ROCK(?)
12. Colluvium, mottled-gray and -brown, silty; few pebbles soft, rotten, compact; may include remnants of old till; underlain by weathered shale

FIGURE 4.—Sketch of glacial deposits exposed in strip mine of former Carbon Limestone Co. in southeastern Poland Township, 500 feet north-northwest of intersection of Miller and Kansas Roads.

WISCONSINAN STAGE

ALTONIAN SUBSTAGE—TITUSVILLE TILL

In the area of the Michigan lobe in Illinois, the Early Wisconsinan substage has been named Altonian (Frye and Willman, 1960), and this terminology has been used in Ohio and Pennsylvania (White, Totten, and Gross, 1969; Totten, 1973). The Titusville Till, along with associated outwash, was deposited in Mahoning County during the Altonian Substage.

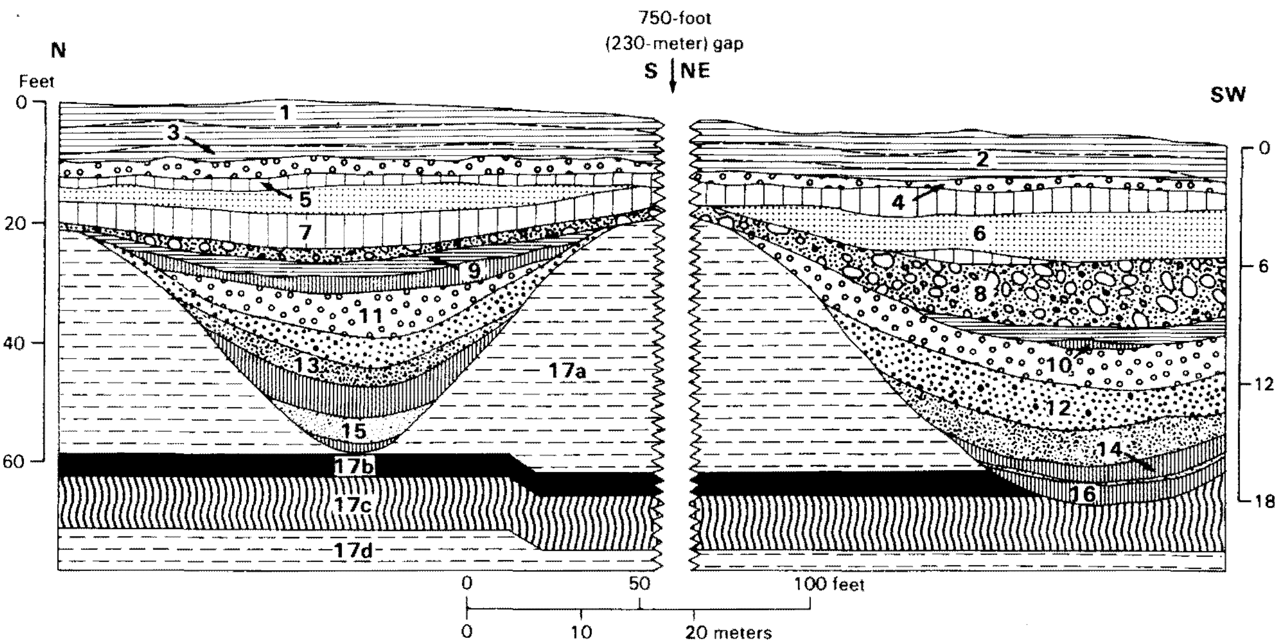
The Titusville Till is named (White and Totten, 1965) for exposures near Titusville in northwestern Pennsylvania and has been traced southwestward into eastern Ohio (White, Totten, and Gross, 1969). This till has been intensively studied since 1965 for several reasons: (1) strip mine and highway excavations have exposed thick sections of till, (2) Titusville Till is considerably thicker than other tills and makes up the bulk of the glacial deposits on the Allegheny Plateau, and (3) most of the thick, high-quality gravel deposits are associated with Titusville Till.

The glacier that deposited the Titusville Till covered all of Mahoning County and the northern half of Columbiana County. Titusville Till is buried beneath younger deposits nearly everywhere in the county. The till generally overlies bedrock, although in a few places one or more older tills are present beneath Titusville Till (figs. 5, 6, 7). Most sections show the Titusville Till to be composed of more than one unit having a composite thickness averaging about 20 feet (see figs. 4, 5, 6, 8, 9).

The Titusville Till is sandy, stony, hard, and compact. Thick extensive manganese stains coat pebbles and joint surfaces. The composition of the matrix averages 43 percent sand, 38 percent silt, and 19 percent clay.

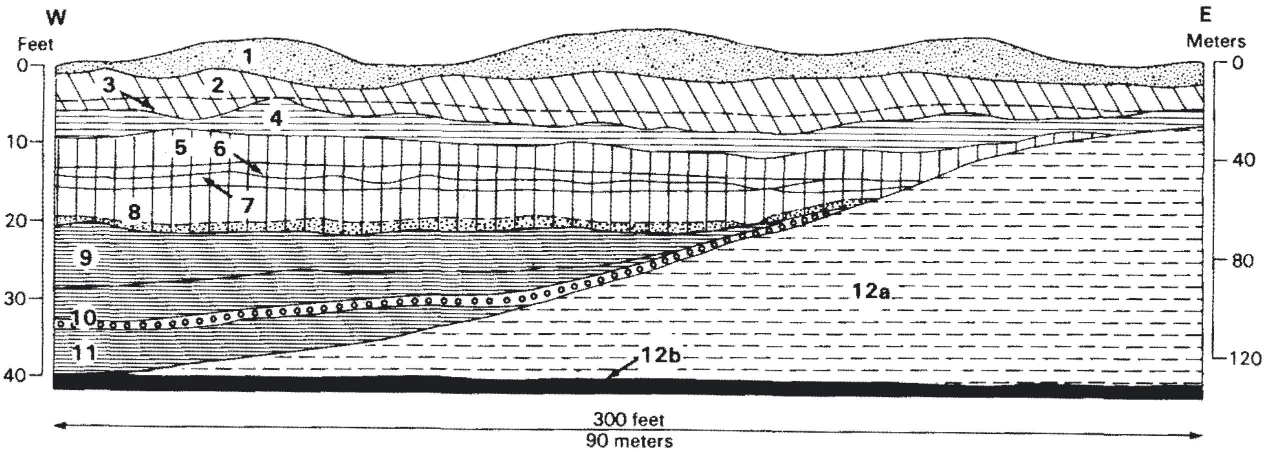
In Pennsylvania the sand content of the till increases in an orderly fashion toward the glacial boundary (White, Totten, and Gross, 1969). Gross and Moran (1971) indicate that a similar gradation in feldspar content toward the margin is the result of dilution of till with locally derived materials; furthermore, Gross and Moran present evidence that more than 50 percent of the Titusville Till was derived from within 20 miles of the site of deposition.

Unaltered Titusville Till (horizon 5) is dark olive gray, whereas the oxidized color (horizon 4) is a distinctive olive brown (2.5Y 4/4). The depth of oxidation and the depth of leaching cannot be determined precisely because of profile truncation and the influence of younger deposits. Oxidized Titusville Till is characterized by angular blocky structure



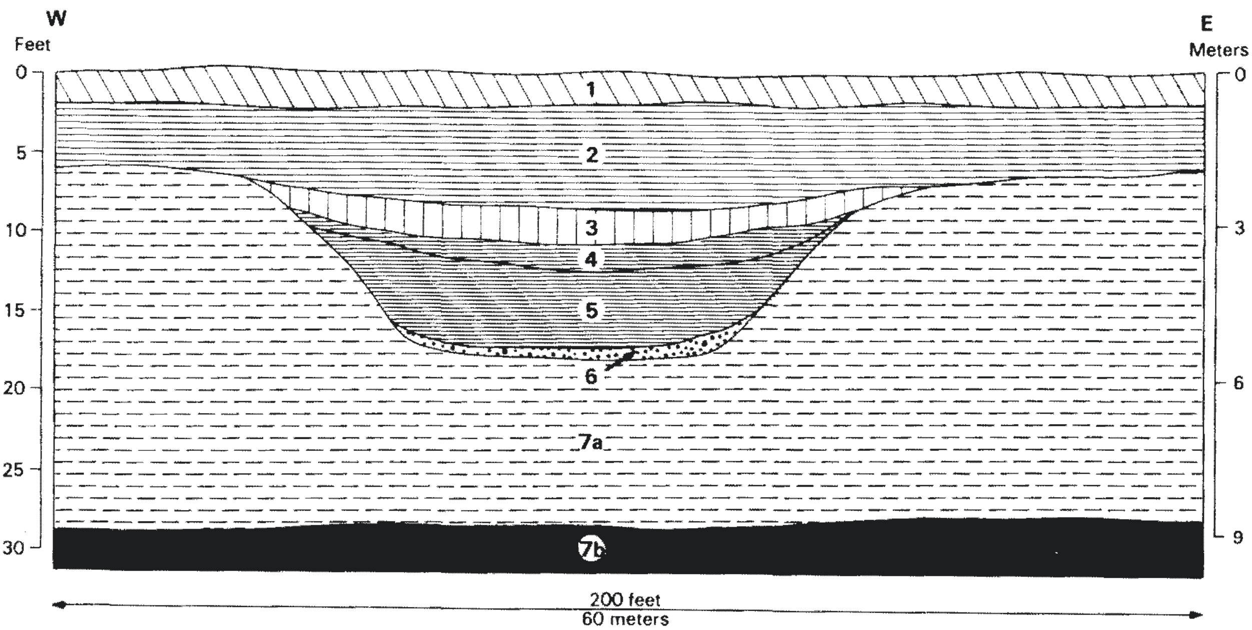
1. Till, yellow-brown, noncalcareous. KENT
2. Till, yellow-brown, calcareous. KENT
3. Till, dark-olive-gray, calcareous. KENT
4. Gravel, grayish-brown, calcareous
5. Till, olive-gray, stony, hard, calcareous. TITUSVILLE I
6. Silt, olive-gray, very calcareous
7. Till, olive-gray, pebbly, calcareous. TITUSVILLE III
8. Sand and gravel, gray, water-bearing, calcareous
9. Till, dark-olive, calcareous; sparse pebbles; bedrock and soil inclusions. MAPLEDALE
10. Till, dark-gray, intensely weathered; all pebbles soft and easily crumbled; upper 8 inches darker gray brown with organic matter. SLIPPERY ROCK
11. Gravel, olive-brown, intensely weathered; pebbles easily broken
12. Silt, sand, and fine gravel, interbedded, dark-gray; all pebbles of local bedrock, soft and crumbly
13. Silt, dark-gray-brown, peaty; many small stems and rootlets
14. Till, olive-gray, pebbly; all pebbles rotted and easily crushed. SLIPPERY ROCK(?)
15. Silt, mottled-gray, -yellow, and -strong-brown, massive; small stems and other traces of organic matter
16. Till, strong-brown, much-weathered; few crumbly sandstone pebbles; paleosol developed in upper part. SLIPPERY ROCK(?)
17. Bedrock, shale (17a, 17d), coal (17b), clay (17c)

FIGURE 5.—Sketch of glacial deposits exposed in strip mine in NW¼SE¼ sec. 18, T. 9 N., R. 1 W., Springfield Township.



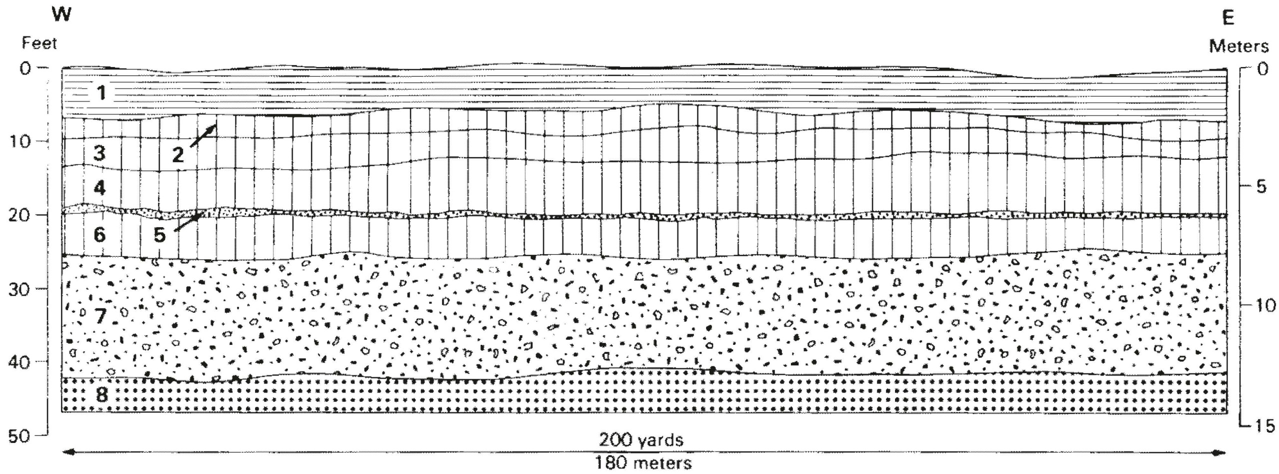
1. Silt and sand
2. Till, dark-brown to dark-yellow-brown, silty, noncalcareous. LAVERY
3. Till, dark-brown, silty, calcareous; 27 percent sand, 34 percent clay. LAVERY
4. Till, light-olive-brown to yellowish-brown, sandy, silty, calcareous; 34 percent sand, 25 percent clay. KENT
5. Till, olive-brown, rusty, blocky, pebbly, calcareous; 34 percent sand, 23 percent clay. TITUSVILLE I
6. Till, olive-gray, calcareous; 35 percent sand, 23 percent clay. TITUSVILLE I
7. Till, olive-brown, rusty, blocky, calcareous. TITUSVILLE II
8. Till, olive-gray, calcareous; sandy zone at base; 39 percent sand, 20 percent clay. TITUSVILLE II
9. Till, olive-gray, sandy, crumbly, slabby; 37 percent sand, 22 percent clay. MAPLEDALE I
10. Till, dark-olive-gray to very dark gray; boulder zone at base; 41 percent sand, 23 percent clay. MAPLEDALE I
11. Till, dark-gray-brown, loose, crumbly; very fine texture; 38 percent sand, 22 percent clay. MAPLEDALE II
12. Bedrock, shale (12a) and coal (12b)

FIGURE 6.—Sketch of glacial deposits exposed in strip mine in SW¼SW¼ sec. 24, T. 18 N., R. 5 W., Smith Township.



1. Till, silty, and silt; weathered. LAVERY
2. Till, yellow-brown, weathered. KENT
3. Till, olive-brown, noncalcareous. TITUSVILLE
4. Till, gray, hard, noncalcareous. MAPLEDALE I
5. Till, gray, calcareous. MAPLEDALE II
6. Gravel, coarse, noncalcareous
7. Bedrock, shale (7a) and coal (7b)

FIGURE 7.—Sketch of glacial deposits exposed in strip mine in NE¼NW¼ sec. 29, T. 17 N., R. 4 W., Goshen Township.



1. Till, yellow-brown, sandy, pebbly; leached 5 feet. KENT
2. Till, olive-brown, leached, partly weathered. TITUSVILLE I
3. Till, olive-brown, calcareous, sandy, stony, hard. TITUSVILLE I
4. Till, olive-gray, calcareous, sandy, stony, hard. TITUSVILLE I
5. Sand, water-bearing
6. Till, gray, calcareous, sandy, stony. TITUSVILLE II
7. Gravel, gray. TITUSVILLE
8. Bedrock, sandstone

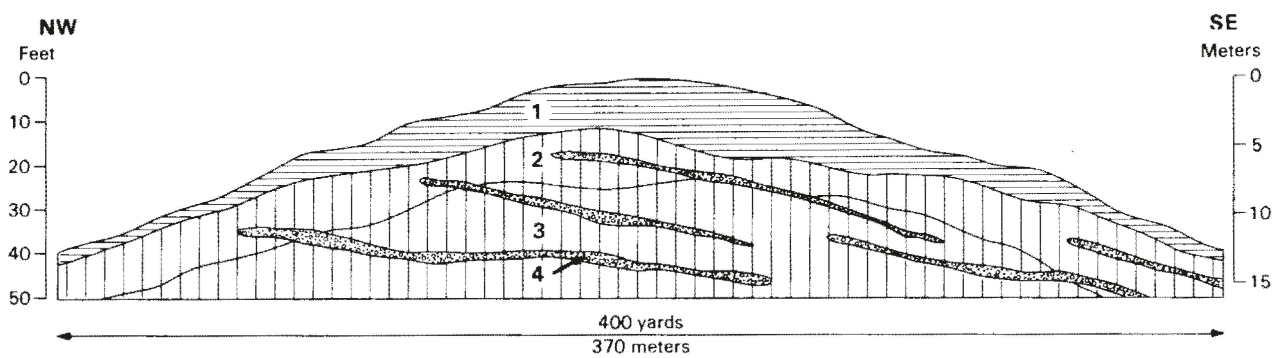
FIGURE 8.—Sketch of glacial deposits exposed in strip mine in SW¼NW¼ sec. 34, T. 9 N., R. 1 W., Springfield Township.

and rusty stains.

Thick Titusville Till and associated sand and gravel are present beneath younger deposits in many strip mines, road cuts, and gravel pits (figs. 8, 9). The thickest and most extensive deposits of Titusville Till are in the southeastern portion of the county, where the entire Pleistocene section is exposed in strip mines. Moran (1967) studied 5 miles of continuous exposures along the Pennsylvania-Ohio state line, and similar strip-mine exposures in northwestern Pennsylvania were recorded by White, Totten, and Gross (1969). From the many stratigraphic records it is apparent that Titusville Till and gravel constitute the bulk of the drift in most of these exposures. In most sections the Titusville Till rests directly on bedrock which has been glacially eroded.

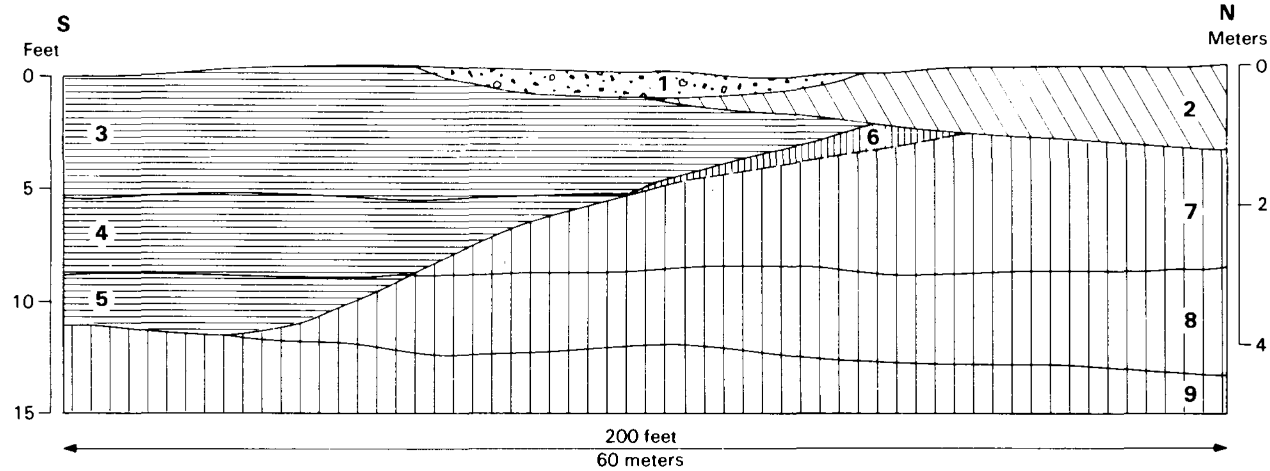
The Titusville Till is a complex stratigraphic unit; it commonly consists of two to five till subunits in places separated by thin layers of sand or sandy gravel. These subunits apparently are not widely separated in time, as paleosols and other evidence of subaerial weathering do not occur between subunits or within the unit as a whole.

During the early stages of field study it was thought that each subunit represented a separate episode or pulsation of advance and retreat of Titusville ice. However, Moran (1971) has presented evidence that abrupt breaks in feldspar content indicate the presence of one or more thrust faults between till subunits. The concept of thrust stacking may account for the unusually thick Titusville sequence, which averages 20 feet or more; however, the mean thickness of just the uppermost Titusville I unit is 9.2 feet (White,



1. Till, yellow-brown, sandy, pebbly; much gravel intermixed; leached 5 to 12 feet; 42 percent sand, 18 percent clay. KENT
2. Till, olive-brown, sandy to gravelly, stony, calcareous. TITUSVILLE
3. Till, olive-gray, sandy to gravelly, stony, calcareous. TITUSVILLE
4. Sand and gravel, in numerous irregular layers and lenses (shown diagrammatically)

FIGURE 9.—Sketch of glacial deposits (observed in 1954) in road cut for Ohio Turnpike (I-76) through hill 0.6 mile south southwest of Lynns Corners, Canfield Township (at present-day intersection of I-76 and Ohio Route 11).



1. Colluvium, silty; with stones
2. Till, dark-brown, silty, sparingly pebbly, leached; upper part much weathered. LAVERY
3. Till, yellow-brown, sandy, pebbly, noncalcareous. KENT
4. Till, yellow-brown, sandy, pebbly, calcareous. KENT
5. Till, gray, sandy, pebbly, calcareous. KENT
6. Till, very much weathered; base of paleosol. FARMDALIAN
7. Till, olive-brown, sandy, stony, noncalcareous. TITUSVILLE
8. Till, olive-brown, sandy, stony, calcareous. TITUSVILLE
9. Till, olive-gray, sandy, stony, calcareous. TITUSVILLE

FIGURE 10.—Sketch of glacial deposits exposed in building excavation on north side of U.S. Route 422, 100 yards west of Ohio-Pennsylvania state line and 2½ miles east of Coitsville Center, Coitsville Township.

1971b), or about twice the thickness of other tills.

Sand and gravel typically associated with the Titusville glaciation may underlie and overlie Titusville Till, particularly in valleys (see discussion of glaciofluvial deposits, p. 18). In most places the sand and gravel, like the till, are buried beneath younger deposits; where sufficiently thick and accessible, such as in the valley of Middle Fork Little Beaver Creek, this good-quality Titusville gravel is a valuable economic resource.

The Titusville Till is correlative with the Mogadore Till of the Cuyahoga lobe in the Akron region (White, 1960, 1984) and with the Millbrook Till of the Killbuck lobe farther west (White, 1961, 1963, 1967; Totten, 1973). The Titusville Till has a carbon-14 age of 40,000 years B.P. in its type area in Pennsylvania (White, Totten, and Gross, 1969) and therefore is Early Wisconsinan—Altonian in age.

FARMDALIAN SUBSTAGE

After the deposition of the Titusville Till the ice retreated, and a period of weathering and erosion, known as the Farmdalian Substage, followed. The period of weathering was of short duration, about 4,000 to 6,000 years (Willman and Frye, 1970, p. 87), and what little soil did form was mostly removed by the overriding Kent ice. An excavation near the Ohio-Pennsylvania state line (fig. 10) revealed a truncated paleosol more than 1 foot thick developed on Titusville Till beneath Kent Till. In many places this horizon is marked by gravel or a concentration of cobbles, rather than by a buried soil.

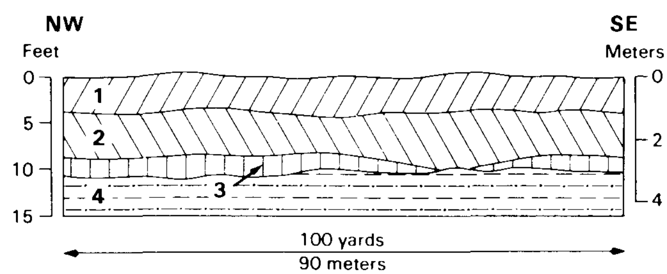
WOODFORDIAN SUBSTAGE

The Late Wisconsinan substage has been named Woodfordian by Frye and Willman (1960). Three tills—from oldest to youngest, Kent, Lavery, and Hiram—along with associated outwash were deposited during the Woodfordian Substage.

Kent Till

The Kent Till is named (White, 1960) for the city of Kent in western Portage County and has been traced from its type locality eastward across Ohio and northeastward into Pennsylvania to New York State (White, Totten, and Gross, 1969).

The Kent glacier covered all of Mahoning County, but the Kent Till is exposed at the surface only in the southeastern corner of the county. In other parts of the county the Kent Till is covered by younger deposits. Kent Till generally is thin throughout the county. In a few places, such as the Lake Milton area, the till is absent (fig. 11), whereas in a few other places, thicknesses of 10 to 12 feet have been recorded.



1. Till, dark-brown, very clayey, noncalcareous; rare pebbles. HIRAM
2. Till, brown, silty, sparingly pebbly, stones at top; calcareous at a depth of 5 feet. LAVERY
3. Till, gray, stony, calcareous. TITUSVILLE
4. Bedrock, shale and siltstone, just above Lower Mercer limestone

FIGURE 11.—Sketch of glacial deposits exposed along southeast edge of Berlin Reservoir at Mill Creek Recreation Area, ¼ mile west of Bedell Road, Berlin Township.

The average thickness of Kent Till in Mahoning County is 5.3 feet, which is slightly less than the 6.8-foot average recorded regionally by White (1971b).

The Kent Till is silty, sandy, loose, and friable and contains many small pebbles and some cobbles. The average composition is 45 percent sand, 38 percent silt, and 17 percent clay.

Columnar sections of averages of weathering horizons developed in Kent and younger tills are shown in figure 12. Unaltered Kent Till (horizon 5) is dark gray where thick enough. Kent Till is oxidized in the upper 10-12 feet (horizon 4) to a distinct yellow brown (10YR 4/4), in contrast to the older olive-brown Titusville Till and the younger chocolate-brown Lavery and Hiram Tills. The depth of carbonate leaching (top of horizon 4) averages 68 inches. Leached till (horizon 3) is stained along some joints, but is otherwise not greatly altered. Horizon 2 is characterized by relatively thick clay coating and manganese and iron stains. The soils developed on Kent Till are mainly the Wooster, Canfield, and Ravenna silt loams (see table 2), which are light colored, well drained, and well suited for general farm crops. These soils are distributed mainly in the southeastern part of the county where the Lavery Till is either discontinuous or too thin to significantly influence the modern soil.

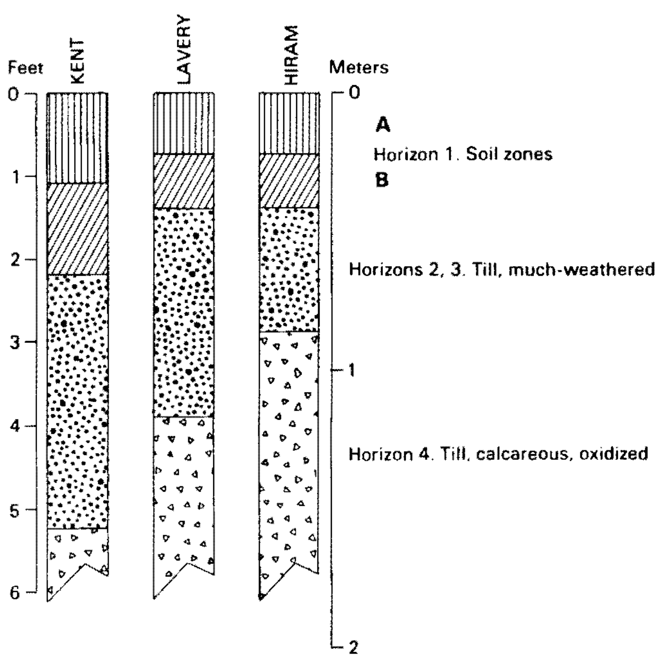


FIGURE 12.—Representative composite sections showing average weathering horizons of tills in Mahoning County.

Sands and gravels of Kent age are thought to occur along major drainage lines (see discussion of glaciofluvial deposits, p. 18). Much of the fine-grained sandy outwash in the valleys of the Mahoning River, Honey Creek, Middle Fork Little Beaver Creek, and Mill Creek (east) is probably of Kent age. The kames east of Lake Milton and at least a portion of the kame terrace in the Mill Creek (east) valley near Columbiana also are considered to be of Kent age. However, much of the gravel in the southern part of the county that was formerly mapped as Kent is buried beneath Kent Till and is most likely of Titusville age.

The Kent Till is correlative with the Navarre Till to the west in the Killbuck lobe (White, 1963, 1967) and with the Catfish Creek Till of Ontario north of Lake Erie (Dreimanis, 1964). Wood from Cleveland, Ohio, overridden by ice of this episode has a carbon-14 age of 24,000 years B.P. (White, 1968); the Kent glacier is thought to have reached its maximum extent between 22,000 and 20,000 years B.P.

Lavery Till

The Lavery Till was named by Shepps (Shepps and others, 1959) for exposures near Lavery, a village west of Edinboro in northwestern Pennsylvania. The Lavery Till has been traced from New York State southwestward across Pennsylvania (White, Totten, and Gross, 1969) into Trumbull and Mahoning Counties (White, 1971a). From Mahoning County it can be traced westward into Stark and Portage Counties (White, 1960).

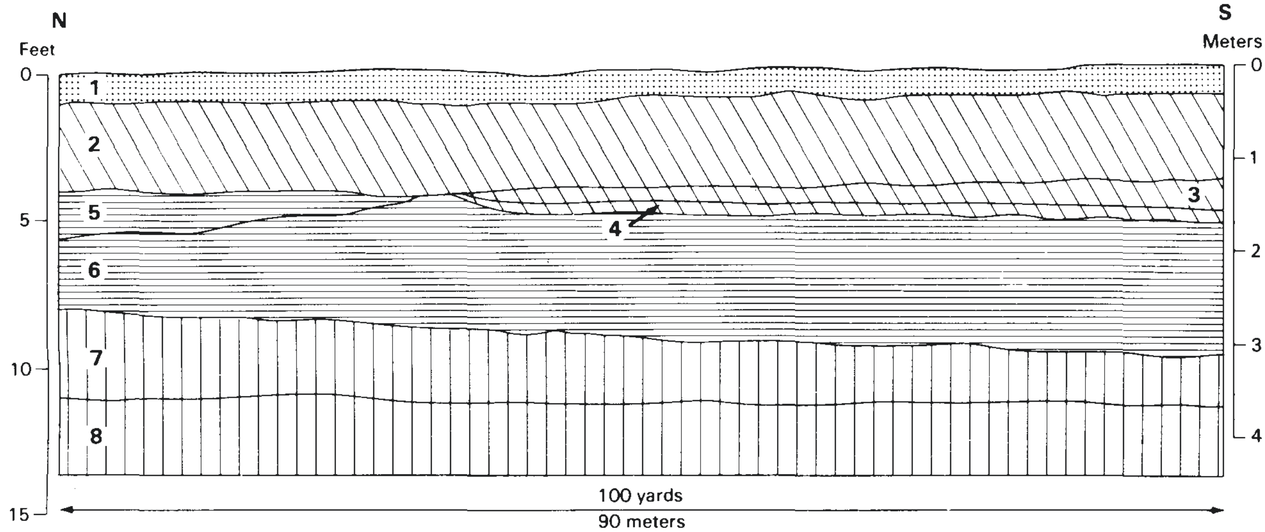
Two boundaries for the Lavery Till are shown on plate 1. The dashed Lavery boundary represents the limits of continuous, thicker till, whereas the other boundary represents the actual outer limit of the Lavery; in its outer margin the Lavery is characterized by thin, discontinuous till. The continuous-Lavery boundary on plate 1 closely approximates the Lavery boundary shown on most published maps (Goldthwait, White, and Forsyth, 1961; Totten, Moran, and Gross, 1969). The Lavery Till ranges up to 12 feet in thickness and has an average thickness of 5.5 feet for all sections in Mahoning County (figs. 13, 14; see also figs. 6, 7, 10, 11, 18, 19, 20) as compared to the 5.0-foot average thickness for the entire Grand River lobe (White, 1971b).

Lavery Till exhibits its thicker, generally continuous phase in the northwestern two-thirds of the county. Lobes of thicker Lavery Till extend south past Alliance in the Mahoning River valley in the southwestern part of the county, south to Salem in the Middle Fork Little Beaver Creek valley, and southeast to Lowellville in the Mahoning River valley in the northeastern part of the county.

Thin and discontinuous Lavery Till extends as much as 10 to 15 miles beyond the continuous-Lavery boundary, a situation similar to that to the east in Pennsylvania (White, Totten, and Gross, 1969). In this outer belt the till may be absent or incorporated into the Kent soil and only rarely masks the underlying Kent Till. The Lavery boundary on plate 1 includes within it all known localities of Lavery Till in Mahoning County.

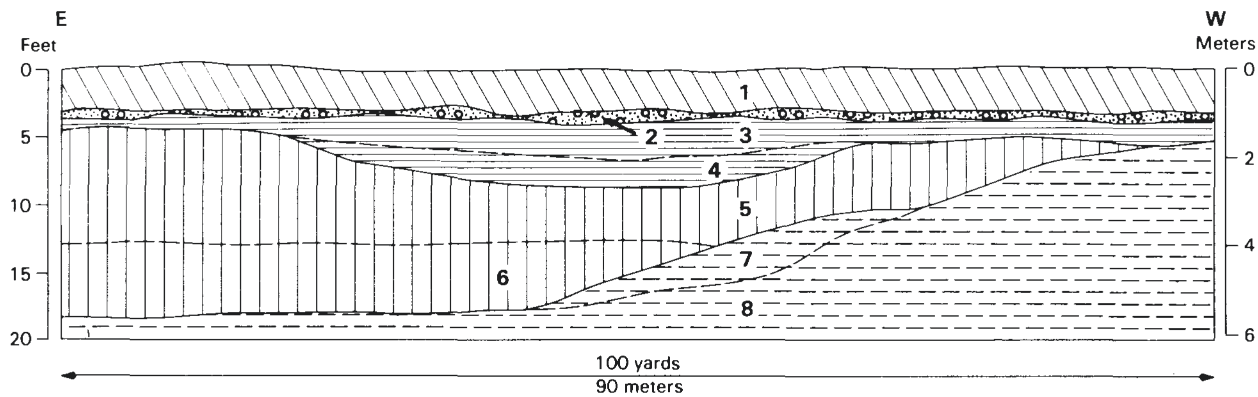
The Lavery Till is predominantly silty and sparingly pebbly. The average composition is 33 percent sand, 41 percent silt, and 26 percent clay.

Average weathering horizons developed in Lavery Till are shown in figure 12. Unaltered Lavery Till (horizon 5) is rarely seen because this till is so thin. Where it is thick enough, the unaltered Lavery Till is dark gray. Lavery Till oxidizes (horizon 4) to a dark chocolate brown (10YR 4/3), a color distinct from the underlying tills, but similar to the younger Hiram Till. The depth of leaching (top of horizon 4) averages 50 inches and is a useful field criterion for distinguishing Lavery Till from the similar Hiram Till. Where Lavery Till is the surface material, the upper 2 to 3 feet (horizons 1, 2, 3) is crumbly and breaks into small chips and chunks.



1. Silt, yellow
2. Till, brown, silty, leached; soil zones at top. LAVERY
3. Till, dark-brown, silty, calcareous; sparingly pebbly. LAVERY
4. Till, gray and purple (color from secondary carbonate). LAVERY
5. Till, yellow-brown, sandy, leached. KENT
6. Till, yellow-brown, sandy, pebbly, calcareous. KENT
7. Till, olive-brown, sandy, stony, very hard, calcareous. TITUSVILLE
8. Till, olive-gray, sandy, stony, very hard, calcareous. TITUSVILLE

FIGURE 13.—Sketch of glacial deposits exposed in excavation for I-680 at U.S. Rte. 224, 1/3 mile east of McKays Corners, Boardman Township.



1. Till, brown, silty, weathered; few pebbles. LAVERY
2. Gravel and sand, rubbly, iron-cemented, hard; thickness ranges from 1 to 12 inches
3. Till, yellow-brown, sandy, pebbly, noncalcareous. KENT
4. Till, yellow-brown, sandy, pebbly, calcareous. KENT
5. Till, olive-brown, sandy, stony, calcareous. TITUSVILLE
6. Till, olive-gray, sandy, stony, calcareous. TITUSVILLE
7. Bedrock, shale, disturbed and broken
8. Bedrock, shale

FIGURE 14.—Sketch of glacial deposits exposed in former Carbon Limestone Co. quarry on west side of State Line Road, ¼ mile north of boundary of the Western Reserve, southeastern Poland Township.

The Rittman-Wadsworth-Frenchtown soil association (Lessig and others, 1971) develops in relatively thick Lavery Till (see table 2). These soils occur mainly in two areas between sublobes of Hiram Till: (1) between the Mahoning River and Meander Creek valleys north-northwest of Salem, and (2) in the Boardman-Campbell-Youngstown area in the vicinity of the Mill Creek (east) and Mahoning River valleys.

The soils developed on thin Lavery Till are the Cardington and Bennington silt loams (Lessig and others, 1971), which are within the Canfield-Ravenna-Wooster soil association, the same soil association as soils formed in Kent Till. The Cardington and Bennington soils occur in four general areas: (1) south of New Springfield, (2) southeast of Evans Lake, (3) east of Poland, and (4) from New Middletown east to the state line.

No outwash has been positively identified with the Lavery Till, although it is possible that at least some of the sandy outwash in valley trains is of Lavery age. In western Trumbull and northeastern Portage Counties, extensive areas of Windham Sand have been interpreted as pro-Lavery outwash (White, 1960, p. 7).

The Lavery Till is correlative with the Hayesville Till of the Killbuck lobe farther west (White, 1963, 1967) and may be correlative with either the latest Catfish Creek drift or possibly with the Port Stanley drift of Ontario (Dreimanis, 1964). No wood or other organic matter which could provide a carbon-14 date has been found in association with the Lavery Till in Mahoning County. Estimates of the age of the Lavery Till in the county range from a maximum of 19,000 years to a minimum of 16,000 years.

Hiram Till

The Hiram Till, the youngest till in Mahoning County, was named (White, 1960) for the village of Hiram, in northeastern Portage County. The till has been traced from Richland County (Totten, 1973) in north-central Ohio eastward into Pennsylvania (Shepps and others, 1959) and northeastward into New York State (Muller, 1963).

As the Hiram ice advanced southward in the Grand River basin, it split into two sublobes—one advanced into the Mahoning River valley to Alliance and Sebring, and the other advanced into the Meander Creek/Middle Fork Little Beaver Creek valleys to within 2½ miles of Salem, Columbiana County (pl. 1). Hiram ice apparently was thin and very sensitive to slight topographic differences because no significant topographic upland separates the two valleys. From the valley of Middle Fork Little Beaver Creek the Hiram boundary extends northeastward to Canfield, Austintown, and the northwestern corner of Youngstown, where it makes a slight projection into the Mahoning River valley.

The Hiram Till is a persistent unit in northwestern Mahoning County, and its distinctive characteristics permit its identification even where the till is thin. The till is very clayey, very sparingly pebbly, and at many places superficially resembles lacustrine clay. A north-south-trending pipeline excavation east of Lake Milton and Berlin Reservoir was followed for several miles and showed the Hiram to be a nearly continuous layer generally 2 to 5 feet thick (up to 8 feet thick locally) overlying Lavery Till (see fig. 11). The Hiram Till averages 5.6 feet thick, which compares favorably with the 5.8-foot regional average (White, 1971b). The average composition of Hiram Till is 10 percent sand, 48 percent silt, and 42 percent clay.

Average weathering horizons developed in Hiram Till are shown in figure 12. The color of the Hiram Till is similar to the color of the Lavery Till: dark gray where unaltered (horizon 5) and dark chocolate brown (10YR 4/3) where oxidized (horizon 4). The depth of leaching (top of horizon 4) averages 36 inches. The till is highly calcareous and a secondarily enriched gray carbonate zone is present near the top of horizon 4. When dry the upper 3 feet of Hiram Till has a faint lilac tinge. At many places the till has widely spaced (4-inch) joints, in some places filled with clay, which impart a vertical prismatic structure. The till is sticky when wet and brick hard when dry, making it most difficult to excavate in either case. Hiram Till has a fairly high shrink-swell character. A sun-baked Hiram surface develops large cracks into which water percolates until swelling closes the cracks.

Soils (see table 3) derived from Hiram Till are poorly drained, a result of a clayey subsoil and nearly featureless topography. The Mahoning-Ellsworth-Trumbull soil association (Lessig and others, 1971), which is derived from thin Hiram Till, is mapped in northwestern Mahoning County, east of Austintown, and northwest of Youngstown. The more poorly drained Geeburg-Remsen-Trumbull soil association (Lessig and others, 1971) is mapped in a belt about 2 to 4 miles wide (fig. 15) where the Hiram attains greater thicknesses (up to 10 feet). This belt of thicker Hiram Till occupies the position expected for a Hiram end moraine, although no perceptible moraine feature is recognized topographically. This thicker till may be the result of thrust stacking, as proposed by Moran (1971).

In numerous exposures the uppermost foot of surface material consists of materials washed into slight hollows on the Hiram Till surface. These washed materials of sand, silt, and clay are neither strictly outwash nor lacustrine deposits, but might be more correctly called accretion material. Soils developed in accretion material differ widely in character, and include the poorly drained Sebring-Fitchville soils and the better drained Jimtown-Bogart soils.

Outwash sand and gravel deposits relatable to the Hiram ice advance have not been identified in Mahoning County. Possibly some fine-grained outwash in the valley trains is of Hiram age.

No wood or other organic matter which could provide a carbon-14 date has been found in association with the Hiram Till in Mahoning County. Organic matter at Lodi, in Medina County (Totten, report in preparation), has a carbon-14 age of about 14,500 years B.P., which is a minimum date for the retreat of Hiram ice. Estimates of the age of the Hiram ice advance in Mahoning County range from a maximum of 17,000 years to a minimum of 15,000 years.

GLACIOFLUVIAL DEPOSITS

A large volume of sorted and stratified glaciofluvial sand and gravel was deposited by glacial meltwater streams in Mahoning County, mostly in the larger valleys. Many gravel pits in the county have provided an excellent opportunity to study the stratigraphy of the sand and gravel deposits. Many of the criteria used to date tills apply also to sand and gravel. In most instances the sand and gravel are veneered by later deposits of till, a situation which may require the removal of considerable overburden in a sand and gravel mining operation.

Sand and gravel deposits form several distinct kinds of landforms, such as kames, kame terraces, and valley trains; the morphology of these landforms are described on p. 5-7. The stratigraphic relationships of the sands and gravels described below are illustrated in the columnar sections and sketches throughout this report.

KAMES

Individual kames are rare in Mahoning County, but rather the kames are grouped into irregular patches associated with hummocky topography. One such area is located 2½ miles east of Lake Milton, where poorly sorted sandy gravel, 8 feet thick or more, is exposed in low kames excavated for fill. A similar excavated kame occurs at Shrader Corners 2½ miles to the south. These sands and gravels are thought to be either Lavery or Hiram in age because of the poor quality and absence of till cover.

A large kame complex near Midway Church about 3 miles northwest of Columbiana is nearly a mile wide. Ohio Route 11 cuts through the till-capped kames and exposes thick kame gravels at depth. Gravel nearly reaches the surface in the highest part of the kame. A small deposit of gravel occurs in the solitary kame wedged beside a bedrock hill ½ mile south of the Midway Church kames.

Kame gravels may be more extensive than indicated on plate 1 because gravel may occur at depth beneath till. Many of the areas mapped as gravelly moraine on plate 1, such as the area east of Calla, exhibit typical kame topography and may be buried kames.

The coarse-textured, well-drained Chili and Conotton soils (Lessig and others, 1971) are mapped in kame areas where gravel is at or very near the surface.

KAME TERRACES

Kame-terrace deposits are present along the sides of the major valleys in Mahoning County and several of their tributaries. These terraces are composed of sand and gravel intermediate in character between kames and valley trains. Coarse-textured, well-drained Chili and Conotton soils

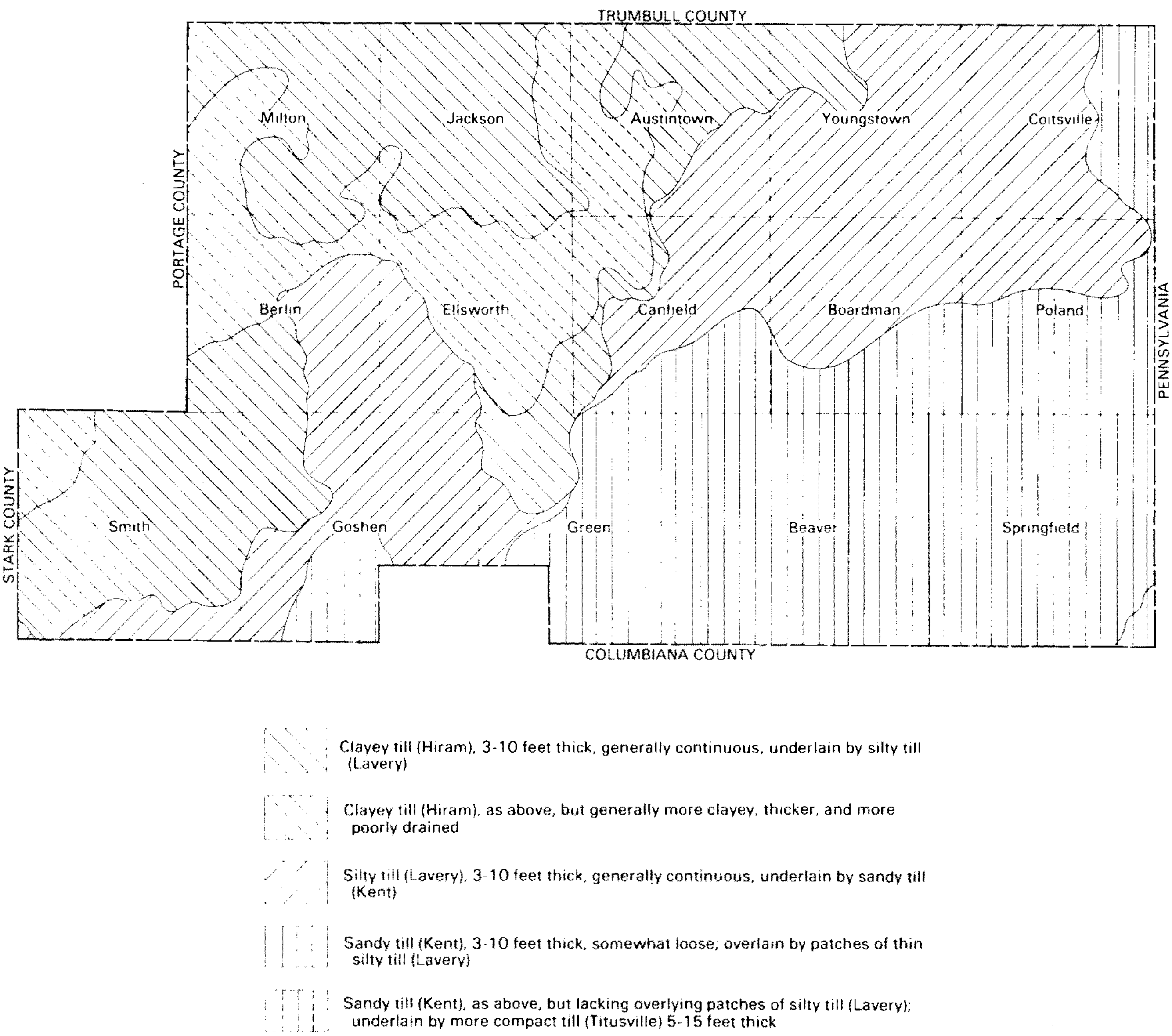


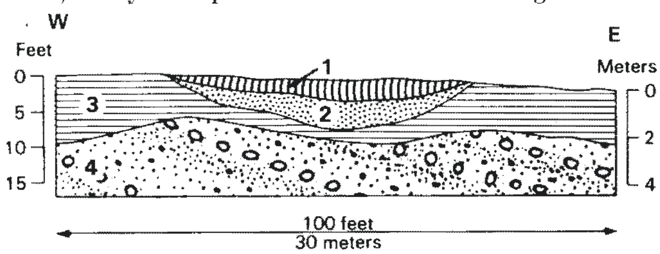
FIGURE 15.—Generalized areal distribution of tills in Mahoning County.

(Lessig and others, 1971) are mapped in kame-terrace areas where gravel is at or very near the surface.

Middle Fork Little Beaver Creek valley

Extensive kame terraces are present in the valley of Middle Fork Little Beaver Creek, one of the few drainage lines in Mahoning County to establish a direct southward flow away from the ice margin. The southward stream gradient thus established was sufficient to transport larger sized material and to remove the finer particles. As a result, the sands and gravels in the valley of Middle Fork are coarser and thicker than those in other Mahoning County valleys.

A number of pits have been operated for many years in the Middle Fork terraces northeast of Salem and the sands and gravels are well exposed. In a pit (fig. 16) in sec. 33, Green Township, coarse, sandy Titusville gravel 10 feet or more thick was exposed beneath a covering of thick Kent Till. A pit along Egypt Road in the center of sec. 33 near Millville quarried very coarse, bouldery Titusville gravel about 50 feet thick. Excavation at this pit in 1973 uncovered the top of an older gravel beneath the Titusville gravel. This older gravel, of unknown extent and thickness, is fine grained and has a hard, rusty, cemented, weathered appearance; it may be Mapledale outwash of Illinoian age.



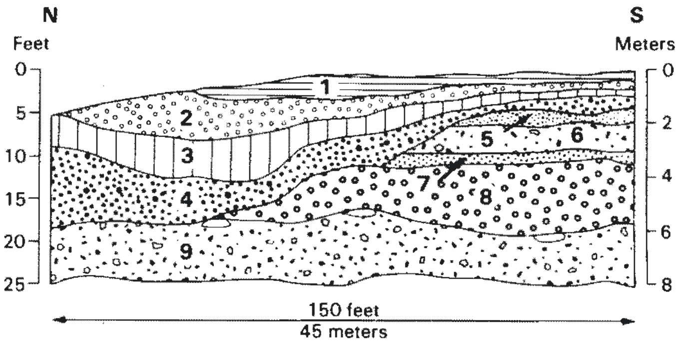
1. Clay, gray, dense, tough; blocky when dry (accretion glei)
2. Sand, orange-yellow to brown, clayey, very much weathered; with gray and orange layers
3. Till, yellow-brown, sandy, pebbly. KENT
4. Gravel, brown, variably coarse to sandy, crossbedded. TITUSVILLE

FIGURE 16.—Sketch of glacial deposits exposed in gravel pit excavated in a kame terrace in valley of Middle Fork Little Beaver Creek, in NW¼NW¼ sec. 33, T. 16 N., R. 3 W., Green Township.

The kame terrace on the north side of Middle Fork near Millville is wider and more extensive than that on the south side. Now-abandoned pits revealed 20 to 30 feet or more of good-quality coarse, sandy gravel, in places interbedded with lenses of silt and sand and covered with thin discontinuous Kent Till. These good-quality gravels extend south into Columbiana County.

Cherry Valley Run valley

The kame terraces in the valley of Cherry Valley Run are similar to, and probably related to, the terraces in the Middle Fork Little Beaver Creek valley. In a pit 1 mile north of Washingtonville, several gravel units were exposed beneath a covering of till (fig. 17). The uppermost gravel is an outwash deposit sandwiched between the Kent and Titusville Tills. A second gravel layer, which is indurated, weathered, and up to 10 feet thick, immediately underlies the Titusville Till and may be an early Titusville deposit. Fifteen feet of older coarse gray-brown sands and gravels (units 5-8, fig. 17) underlie the Titusville gravel. These sands and gravels, calcareous only in the lower 2 feet, are truncated by the Titusville gravel and are thought to be Mapledale in age.



1. Till, light-yellow-brown, silty, mealy, noncalcareous, weathered. KENT
2. Gravel, dark-reddish-brown, rusty, noncalcareous, weathered. KENT or TITUSVILLE
3. Till, brown, sandy, hard, moderately pebbly, noncalcareous, much-weathered. TITUSVILLE
4. Gravel, reddish-brown, hard, clayey, noncalcareous, much-weathered. TITUSVILLE(?)
5. Sand, reddish-brown and gray-brown, poorly sorted, noncalcareous. MAPLEDALE(?)
6. Gravel, reddish-brown and gray-brown, coarse, noncalcareous. MAPLEDALE(?)
7. Sand, brown, water-bearing, noncalcareous. MAPLEDALE(?)
8. Gravel, dark-gray-brown to reddish-brown, sandy; lower 2 feet calcareous. MAPLEDALE(?)
9. Gravel, reddish-brown to olive-brown, noncalcareous, sand lenses. pre-MAPLEDALE(?)

FIGURE 17.—Sketch of glacial deposits exposed in gravel pit east of Washingtonville Road 1 mile north of Washingtonville, in NW¼NW¼ sec. 36, T. 16 N., R. 3 W., Green Township.

The lowermost sandy gravel in the pit is weathered and appears to be older than Mapledale. Terrace gravels are present farther north in the valley but are not well exposed and very little is known about their quality and thickness.

Mahoning River and Crab Creek valleys

Kame terraces are present at a high elevation on the north wall of the gorgelike valley of the Mahoning River near Lowellville. Coarse, rubbly gravel about 35 feet thick and leached only about 4 feet is well exposed in an abandoned pit about 1,000 feet east of the state line. The age of this gravel is in doubt; it may be either Kent or Titusville. Other portions of this kame terrace are poorly exposed, particularly in the Youngstown area, where urban construction has obscured the deposits. A fairly extensive kame terrace is present along the east side of Crab Creek and its tributaries in northeast Youngstown. In a pit south of McGuffey Road, 16 feet of sandy gravel is exposed; this gravel is probably Kent in age.

Meander Creek valley

Kame-terrace gravels in the valley of Meander Creek are exposed in a large abandoned pit at Westhill Heights, 4 miles west of Canfield. The sandy gravel is about 20 feet thick, rusty, deeply weathered, poorly sorted, and consists mostly of local bedrock pieces. The gravel is buried beneath 7 to 10 feet of Hiram, Lavery, and Titusville Tills. This deposit, most of which is shown on plate 1 as gravelly moraine, probably represents a buried Mapledale kame terrace.

Mill Creek (east) valley

The extensive kame terrace in the valley of Mill Creek (east) developed when the drainage flowed south into Little Beaver Creek. In an abandoned pit (fig. 18) about 1¼ miles south of East Lewistown, about 30 feet of sandy gravel is exposed beneath Lavery Till. In the vicinity of Arrowhead Lake near the Columbiana-Mahoning County line the terrace is composed of 20 feet of gravel overlain by thick Kent Till and Lavery Till. Most of the gravel in this terrace appears to be Titusville in age, although some may be Kent in age.

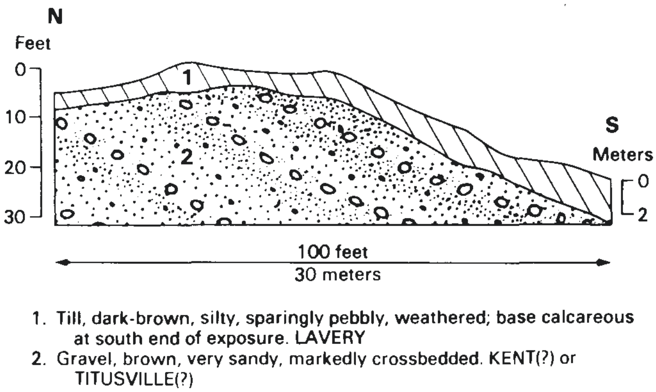


FIGURE 18.—Sketch of glacial deposits exposed in gravel pit excavated in a kame terrace on west side of Mill Creek valley, in NW¼NE¼ sec. 28, T. 13 N., R. 2 W., Beaver Township.

Other kame terraces

Several smaller kame terraces are poorly exposed in other valleys. The kame terrace in the valley of Yellow Creek is mostly covered with water of three reservoirs. Nowhere in this valley is good-quality gravel evident. In the Honey Creek valley as much as 18 feet of gravel occurs in small terrace segments, but the deposits of this valley mostly have been obliterated by strip mining.

Kame-terrace gravels are exposed in two places in the valley of North Fork Little Beaver Creek. Where the Ohio Turnpike crosses the valley an excavation exposed poorly sorted medium-sized gravel 20 feet thick. In a strip mine 3 miles south of the Turnpike exposure, near the county line, Titusville terrace gravel 13 feet thick is buried beneath 25 feet of till (see fig. 8).

The kame terrace in the valley of Mill Creek (west) and Garfield Ditch upstream from Berlin Reservoir is fairly extensive and continuous but no pits have been developed in it. In a few places poor-quality Kent sand and gravel of undetermined thickness are exposed beneath 5 to 7 feet of Hiram and Lavery Tills.

A portion of the gravel in the Mahoning River valley at the Stark-Mahoning County line is a buried kame terrace (figs. 19, 20). In a gravel pit along the Stark-Mahoning County line, sandy crossbedded gravel 20 feet thick is overlain by sand and as much as 15 feet of Kent and Lavery Tills (fig. 20). This potentially valuable gravel deposit of probable Titusville age is difficult to trace because of its thick till cover.

The nature of the kame terraces in the valley of East Branch Middle Fork Little Beaver Creek in Mahoning County is unknown because of a lack of exposures. A short distance south in Columbiana County extensive deposits of sandy gravel are exposed in several pits (White and Totten, 1985).

OUTWASH

Meltwater flowing away from wasting ice sheets carried much sediment that partially filled several valleys in Mahoning County with outwash deposits of silt, sand, and gravel in the form of valley trains. Much of the valley-train material is fine grained because of the low stream gradients and ponded conditions that resulted from the general northward slope of the drainage toward the ice. Valley-train gravels generally are of poor quality, have a position low in the valley just above the modern floodplain, and are near the water table. Consequently, few pits have been excavated in the valley trains and exposures are few. Soils mapped in valley-train terraces are the somewhat poorly drained Jimtown and Fitchville soils and the moderately well drained Bogart soil (Lessig and others, 1971).

The valley train of Honey Creek is one of the most

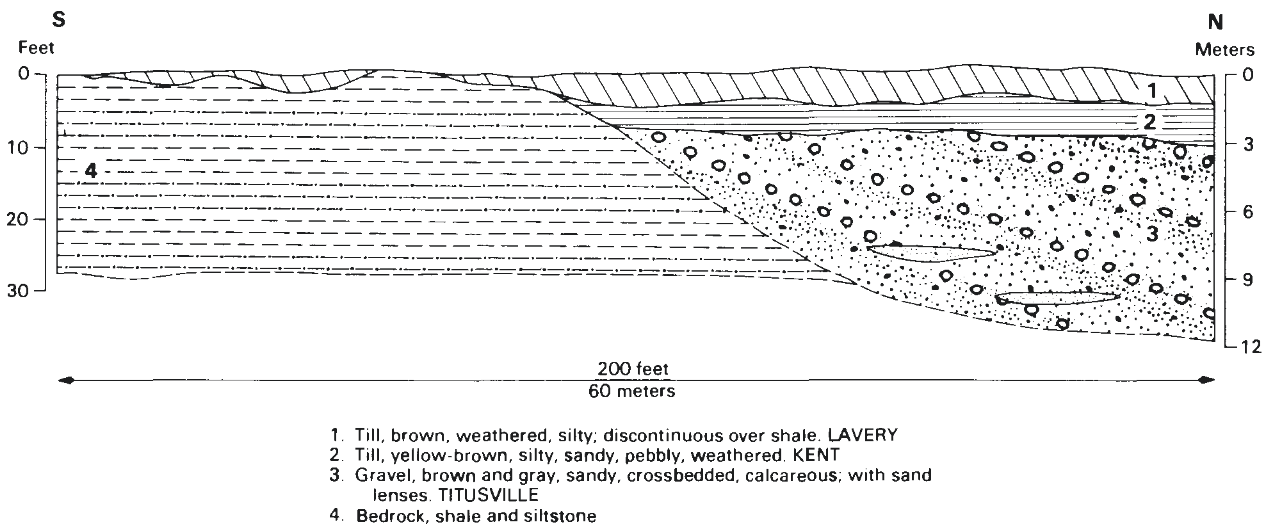
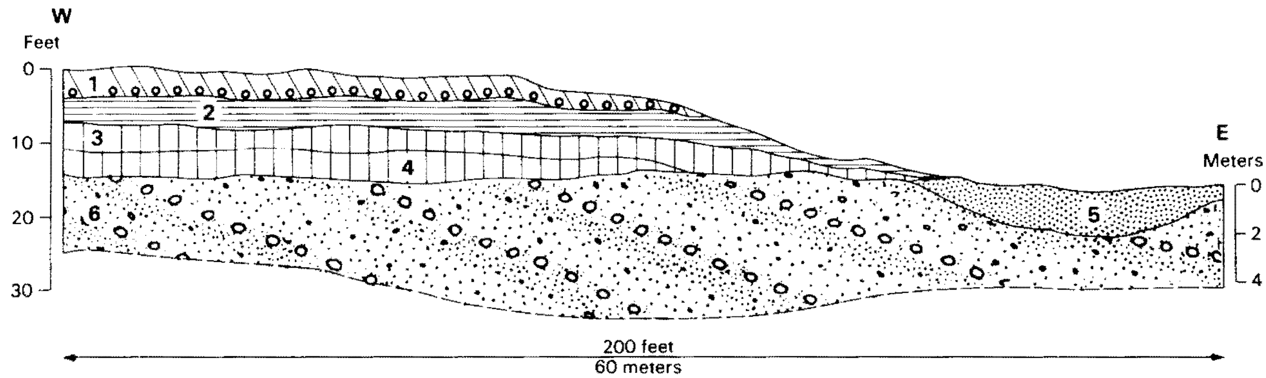


FIGURE 19.—Sketch of glacial deposits exposed in Whitacre-Greer Fireproofing Co. shale and gravel pit on west side of Mahoning Avenue in Alliance, in NE¼SE¼ sec. 36, T. 19 N., R. 6 W., Lexington Township, Stark County, at the Stark-Mahoning County line.

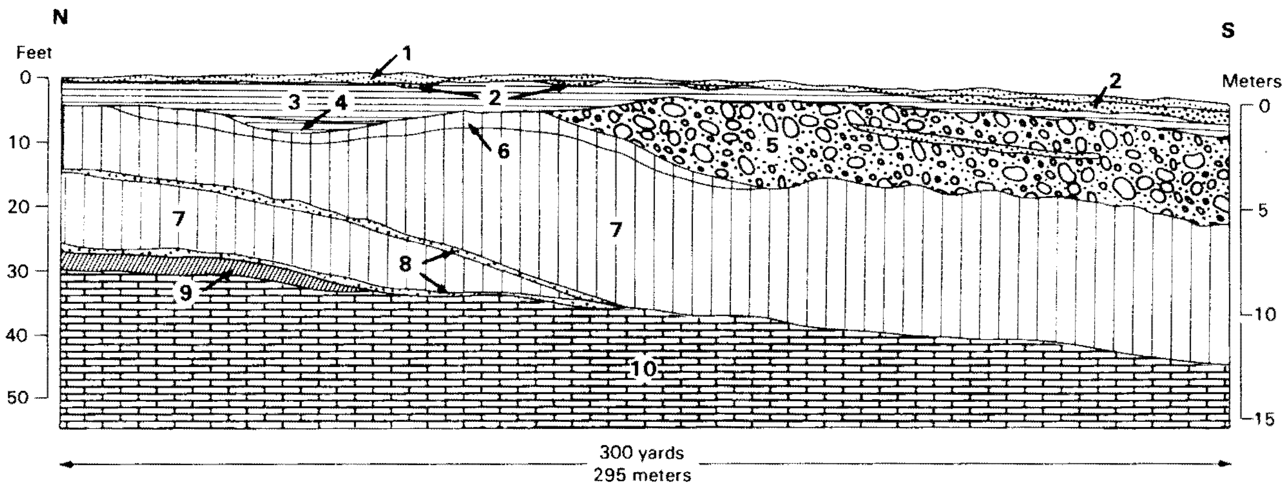


1. Till, brown, weathered, silty; few pebbles; stones at base. LAVERY
2. Till, yellow-brown, silty, sandy, pebbly, weathered. KENT
3. Till, olive-brown, hard, sandy, pebbly, weathered. TITUSVILLE
4. Flowtill, indurated; rubbly zone, many rock fragments in till matrix. TITUSVILLE
5. Sand, brown, loose, well-sorted; channel in Titusville gravel
6. Gravel, sandy, crossbedded, calcareous. TITUSVILLE

FIGURE 20.—Sketch of glacial deposits exposed in gravel pit on west side of Mahoning Avenue in Alliance, in NE¼SE¼ sec. 36, T. 19 N., R. 6 W., Lexington Township, Stark County, at the Stark-Mahoning County line. West end of exposure is 100 feet north of exposure illustrated in figure 19.

extensive outwash deposits in Mahoning County. The stream has cut only a small narrow channel into the valley train, but strip mining has removed much of the deposit. In sec. 22, Springfield Township, poorly sorted medium-grained gravel 10 to 18 feet thick overlies bedrock. At the Honey Creek Stone Company quarry 1½ miles north of Petersburg, in sec. 23, Springfield Township, two episodes of outwash deposition are recorded (fig. 21). Poorly sorted coarse, rubbly Kent outwash is at or near the surface and is underlain by Kent Till; beneath the Kent Till at a depth of about 5 feet is 15 feet of sandy gravel of Titusville age. Both gravels thin toward the north.

The deposits of the valley train in the Mahoning River gorge near Youngstown are best known from drilling records.



1. Silt, yellow-brown
2. Gravel, brown, coarse, rubbly, very poorly sorted, sharp contact at base. KENT
3. Till, yellow-brown, sandy, pebbly; weathered at top. KENT
4. Till, gray, sandy. KENT
5. Gravel, yellow-brown, sandy, silty; some silt layers; cut-and-fill structure; base irregular. TITUSVILLE
6. Till, olive-brown. TITUSVILLE
7. Till, olive-gray, sandy, stony, hard. TITUSVILLE
8. Sand
9. Till, mixed with limestone fragments
10. Bedrock, limestone, in massive beds; upper surface broken and not polished. VANPORT

FIGURE 21.—Sketch of glacial deposits exposed in Honey Creek Stone Co. quarry, 1½ miles north-northwest of Petersburg, in SE¼SE¼ sec. 23, T. 9 N., R. 1 W., Springfield Township.

No pits are known in the outwash, and most of the valley bottom has been changed by man's activity. Drilling records indicate till, silt, and gravel 58 feet thick in the valley near the mouth of Mill Creek (east) and gravel 55 feet thick 1 mile to the east. Thick outwash gravels are reported downstream in the Mahoning River valley to the state line.

The Mill Creek (east) valley south of the gorge in Youngstown contains a broad valley train. This northward-flowing valley was ponded by ice and much of the outwash probably emptied into a proglacial lake. Sand is present at the single exposure recorded for this deposit.

The valley-train outwash in Meander Creek is silty, sandy, and largely covered by water of the reservoir. The northward slope of the valley resulted in ponding of outwash; consequently, much fine-grained material was incorporated. Near Lipkey Corners west of the reservoir, brown sand about 3 feet thick is exposed beneath Hiram Till. All other exposures are of silt and clay.

Sandy gravel 10 feet thick overlies bedrock in the extreme southwestern corner of the county near Alliance. This gravel, which is part of a broad valley train of the Mahoning River, is overlain by Kent and Lavery Tills and is either Kent or Titusville outwash. Similar silty gravel is exposed on the east side of the Mahoning River valley.

The wide valley train of Naylor Ditch northwest of Damascus is composed of sandy outwash pitted with several large kettle holes filled with peat.

LATE-GLACIAL AND POSTGLACIAL DEPOSITS

After the melting of the last (Hiram) ice sheet to invade Mahoning County approximately 15,000 years ago, a rather complex series of events including soil formation, lake filling and draining, reforestation, and animal repopulation began, continuing to the present. The Erie glacial lobe did not disappear immediately, but continued to fluctuate in the northern Lake Erie region until about 10,000 years B.P. (Mörner, 1970), a date which may be considered to mark the change from late-glacial to postglacial time in the Erie basin.

LAKE AND STREAM DEPOSITS

Predominant among post-Hiram deposits are lake sediments and stream deposits (alluvium). Numerous bogs, swamps, and kettle holes resulted from uneven and irregular deposition of drift, in many places in conjunction with buried ice blocks. Ice-dammed lakes that occupied the northward-sloping valleys were drained as soon as the ice dam melted, but the smaller kettle lakes persisted much longer. Fine silt or clay sediments accumulated in these lakes more or less continuously until the lakes were filled. Vegetation growing around or in lakes and swamps accumulated as peat in some of the lakes. Sebring and Fitchville soils are mapped in areas of lacustrine silt and clay (Lessig and others, 1971). These poorly drained soils generally require ditching and tiling for general farming. Many kettle holes remain as swamps unsuitable for general farming; such areas in most cases are relegated to pasture and woodland.

After deglaciation, many of the streams, with some modification, were reestablished in their former valleys. With a decreased load and volume after meltwater runoff subsided, many postglacial streams now seem undersized for the large valleys they occupy. In many instances the floodplains of present streams occupy only a portion of the valley a few feet below the lowest terrace levels. The stream alluvium consists of highly variable clay, silt, sand, and gravel a few inches to several feet thick. These deposits may be found in practically all valleys in the county which contain moving water at least a portion of the year. Orrville and Wayland soils, which are poorly drained and near the water table, are mapped (Lessig and others, 1971) in these modern floodplain areas. Jimtown, Bogart, and Fitchville soils are mapped (Lessig and others, 1971) in earlier, higher, floodplain levels (terraces of geologists, second bottoms of agronomists), which are present in many places between the modern floodplains and the valley walls.

WINDBLOWN DEPOSITS

Windblown deposits, called loess and consisting almost entirely of silt, mantle the entire county. The loess originated when wind blowing across the broad floodplains of meltwater streams picked up desiccated silt and distributed it as a thin blanket downwind. This loess or silt blanket is very thin, generally less than 1 foot thick, and is incorporated into the modern soil profile. Loess is not mapped on plate 1.

MADE LAND

Made land consists of areas of excavation or filling where the land surface has been modified by man. Made land includes strip mines, quarries, reclaimed land, graded areas, and areas of fill.

Strip mines are common in Mahoning County. No attempt was made to distinguish between spoil piles and open pits on plate 1. Areas that were strip mined after 1978 or 1979 (see dates of 7½-minute quadrangles on pl. 1) are not shown on the map. Considerable amounts of drift are present in the spoil piles, generally mixed with slabs of bedrock.

Extensive areas of graded and filled land are shown on plate 1. The fill may consist of almost any material. Most of these areas are in the floodplain and terraces of the Mahoning River valley and are sites of highways, railroads, and industrial and commercial development.

PLEISTOCENE HISTORY

Pleistocene history in the midwestern United States is made up of four major glacial advances, which are, from oldest to youngest, the Nebraskan, Kansan, Illinoian, and Wisconsinan Stages. These stages are separated by interglacial intervals of warmer climatic conditions, which are, from oldest to youngest, the Aftonian, Yarmouthian, and Sangamonian Stages.

Continental ice sheets spread out of the Erie basin into northeastern Ohio and extended into Mahoning County as the Grand River lobe. The ice advanced up the slope of the Grand River lowland and was gradually slowed and stopped by the bedrock uplands in southern Mahoning and northern Columbiana Counties. All of the ice advances that entered Mahoning County apparently were halted in this manner, but had different limits of extent (see fig. 3).

NEBRASKAN STAGE

A Nebraskan ice advance into northern Ohio is postulated from drainage changes discussed by various authors, most recently by Coffey (1961, p. 306-308). Deposits of the Nebraskan Stage have not been positively identified in Mahoning County. It is possible that some of the greatly altered drift near New Middletown (Totten, Moran, and Gross, 1969) is of Nebraskan age.

AFTONIAN INTERGLACIAL STAGE

Deposits of the Aftonian Stage are not known in Mahoning County. If present, these interglacial deposits are most likely buried under younger deposits in deep valleys.

KANSAN STAGE

It is not known for certain that Kansan ice advanced into Mahoning County. Evidence of an early (Kansan?) ice sheet has been found in northwestern Pennsylvania (White, Totten, and Gross, 1969) not far from Mahoning County. Most or all of the greatly altered drift in buried valleys near New Middletown (Totten, Moran, and Gross, 1969) very possibly is Kansan in age. Elsewhere in Ohio, significant drainage changes are attributed to blockage of northward-flowing drainage by Kansan ice. Based upon this evidence from other counties, it is postulated that the northward-flowing drainage in Mahoning County was reversed during a Kansan ice advance, and that deep valley cutting was an important development.

YARMOUTHIAN INTERGLACIAL STAGE

No Yarmouthian deposits are known in Mahoning County; if present, they are likely buried under younger deposits in deep valleys. The weathering developed in the altered drift near New Middletown may represent interglacial weathering during the Yarmouthian Stage.

ILLINOIAN STAGE

Illinoian ice advanced into Mahoning County at least twice to deposit the two units of the Mapledale Till. Mapledale ice covered all of the county, as evidenced by the presence of Mapledale Till at or near the glacial boundary in northwestern Pennsylvania (White, Totten, and Gross, 1969) and in Columbiana County (White and Totten, 1985). It is likely that some of the gravels in part of the Mahoning River valley and several other valleys are of Illinoian age.

SANGAMONIAN INTERGLACIAL STAGE

A prolonged period of warmer climate known as the Sangamonian Stage followed retreat of Illinoian ice. No Sangamonian deposits are known in the county, and it is likely that erosion was a dominant force, as very little Illinoian till remains.

WISCONSINAN STAGE

ALTONIAN SUBSTAGE—TITUSVILLE ADVANCE

In Early Wisconsinan (Altonian) time, ice advanced into Mahoning County and deposited the Titusville Till. This glaciation, which covered all of the county, is thought to have occurred at least 40,000 years ago, and may have begun as early as 75,000 years ago. Titusville ice advanced and retreated at least three and possibly five times, as evidenced by separate till units within the Titusville deposit. Pulsations of the ice, and possibly thrust-stacking of tills, resulted in accumulations of Titusville Till several tens of feet thick in places. During ice melting and retreat, sand and gravel were deposited as kames, kame terraces, and valley trains. Much of the hummocky topography in the county consists of knolls of thick Titusville till and gravel covered with later deposits. The time between each of the Titusville advances is not known, but probably was not long, as there is very little evidence of weathering between till units. Even so, Titusville ice may have persisted in Mahoning County for many thousands of years, and deglaciation of the Grand River lowland may not have occurred until near the beginning of the Farmdalian interval.

FARMDALIAN SUBSTAGE

After the retreat of the Titusville ice sheet, a period of weathering and erosion of several thousand years' duration followed. This warmer interval lasted from approximately 28,000 years B.P. to 24,000 years B.P., according to radiocarbon dates from several midwestern states. In Mahoning County no datable wood, organic silt, or peat from this interval has been discovered, although organic-rich deposits likely accumulated in Farmdalian lakes and ponds.

WOODFORDIAN SUBSTAGE

Kent advance

The advance of ice southward from the Erie basin about 24,000 years ago (White, 1968) brought the Farmdalian Substage to a close. The Late Wisconsinan Kent glacier covered all of Mahoning County and the northern half of Columbiana County, but did not extend quite as far as the Titusville ice (White and Totten, 1985). The till deposited by Kent ice is thin nearly everywhere. As Kent ice melted and retreated northward about 20,000 years ago, sand and gravel were deposited as kames, kame terraces, and valley trains.

Lavery advance

Lavery ice advanced into Mahoning County about 16,000 to 19,000 years ago and covered all but the southeastern tip of the county; however, the till cover is continuous only in the northern and western parts of the county. Very little sand and gravel is attributable to this ice advance. Following melting of Lavery ice in Mahoning County, slight weathering and erosion took place. The weathering interval was very short, perhaps no more than 200 years in duration.

Hiram advance

After a short weathering interval, ice readvanced approximately 15,000 to 17,000 years ago and deposited the Hiram Till. Hiram ice apparently was very thin by the time it reached Mahoning County. Broad tongues of ice extended part way down the Mahoning River and Meander Creek valleys, but did not reach Columbiana County. The Hiram advance deposited a fairly continuous layer of till over the northwestern part of Mahoning County. Very little sand and gravel is attributable to this advance. Hiram ice melted and disappeared from Mahoning County about 15,000 years ago; subsequent ice advances in the Erie basin did not reach Mahoning County.

POSTGLACIAL HISTORY

Following the retreat of ice from Ohio about 14,000 years ago (White, 1982), the climate in Ohio ameliorated. During the postglacial period, vegetation and animal life gradually migrated back into former habitats as climatic and ecological conditions permitted. Drainage lines became integrated, new tributaries formed to drain the numerous depressions, and erosion removed some drift from hillsides. Alluvium, consisting of clay, silt, sand, and fine gravel, was deposited in most of the valleys, and organic-rich silt and peat collected in kettle holes. Weathering and other soil-forming processes have modified the uppermost few feet of drift to form valuable agricultural soils.

MINERAL RESOURCES

The mineral resources of Mahoning County have long been important in the economic life of the county. Coal, sandstone, limestone, clay, and shale are important resources obtained from bedrock. Oil and gas have been produced and further supplies may possibly be developed.

The glaciation of Mahoning County has resulted in several valuable natural resources. Sand and gravel deposits are extremely valuable, not only as sources of industrial aggregate, but also as ground-water aquifers. The rich agricultural soils in the county have been derived largely from glacial drift. Peat, which has accumulated in kettle holes, is another potential resource.

The maps, figures, descriptions, and discussions in this report indicate the location of promising areas for resources in the drift, as well as areas of little or no promise. This report provides a guide or basis for detailed examination or exploration of any given site being considered for development. No report covering an area as large as a county can be considered a detailed site study; this report is intended to be a guide for such detailed studies and to provide a geological framework of reference for the landowners, mineral producers, land-use planners, and others so they may know what general geological situations and constraints may be expected in any given area.

SAND AND GRAVEL

Sand and gravel deposits occur in many places in Mahoning County. Several large pits have been operated in the past, but in 1986 only one operation reported production (Ohio Division of Geological Survey, 1987). A number of smaller pits are operated intermittently, primarily for township road surfacing and other local uses.

The most evident large supplies of sand and gravel are in the kame terraces in the larger valleys (pl. 1). The sand and gravel in some parts of these kame terraces, as already noted, have a covering (overburden) of till which may reach many feet in thickness. Thick overburden adds significantly to the cost of extracting sand and gravel.

The sand and gravel of the kame terraces are variable in texture and composition. Texture may range from cobbly to sandy over short distances both laterally and vertically, so that careful investigation is wise before planning extensive operations. Composition differs somewhat from place to place, and may depend on the age of the deposit. Although no detailed studies of hardness and durability have been made in this study, it is known that sand and gravel of later age generally are of lower quality. Any large-scale sand and gravel operation should produce a finished product that will meet state requirements. Finishing may include crushing, washing, and screening. If gravels of markedly different quality occur within an area, beneficiating low-quality gravel and blending it with high-quality gravel may produce a product that meets specifications. The occurrence of masses of very high quality gravel in a region of lower quality material is known elsewhere in the Allegheny Plateau. The cause of the pockets or areas of exceptionally good gravel is not clear, but age differences may play a part.

The only active large commercial pit operating in Mahoning County in 1986 was located in Green Township in the extensive kame terrace of Middle Fork Little Beaver Creek east of Salem. Although large amounts of Titusville sand and gravel have been removed by this operation and others now abandoned, large reserves still remain on the north side of the river near Millville. Sand and gravel 50 feet thick are exposed in the working face of the pits, and the total thickness of the terrace may exceed 100 feet in places. Farther north in the Middle Fork valley, the terrace is discontinuous and no sand and gravel are produced. The gravel near Hickory Corners and along Goodman Ditch, although still in the same valley system, may be younger than at Millville, and perhaps of lower quality.

The high-level kame terrace of the Mahoning River east of Lowellville has produced sand and gravel in the past and still contains small reserves. However, most of the kame terrace in the Youngstown-Lowellville area is inaccessible because of urban and industrial development. The same is true for the kame terrace in the Crab Creek valley in northeastern Youngstown. Only small borrow pits now are possible in these terraces in an urban area.

Small amounts of sand and gravel have been produced from the kame terrace in the Mill Creek (east) valley between Columbiana and East Lewistown, and from the terrace in the valley of East Branch Middle Fork Little Beaver Creek northwest of Columbiana. Between these two valleys are the kames at Midway Church. The three highways crossing this kame complex make the excavation of these gravels impossible.

Much of the sand and gravel along North Fork and along Honey Creek have been removed in strip mining, and it is unlikely the remaining deposits will have more than local use.

Sand and gravel have been obtained from two small pits in the kame terrace in the valley of Cherry Valley Run north of Washingtonville. Considerable reserves remain, possibly as far north as Calla, and more sand and gravel likely will be quarried from this terrace in the future.

Large quantities of sand and gravel of Titusville age or older have been quarried from a buried kame terrace along Meander Creek at Westhill Heights west of Canfield. Much additional sand and gravel appear to be present in this deposit.

Small amounts of sand and gravel have been excavated near Duck Creek east of Lake Milton. More sand and gravel remain but the quality is poor, and reserves of this deposit are not large.

Considerable areas of outwash sand and sandy gravel are present in valley trains in the southern part of the county, especially in the southwestern part near Alliance (pl. 1). These deposits generally are thin and near the water table, and therefore are not likely to provide sand and gravel for more than local use.

Sand and gravel are contained in the alluvium of many streams, but these alluvial materials generally are not sufficiently extensive, thick, and accessible for other than infrequent local use.

Much of the sand and gravel of the kame terraces is above the water table, in places tens of feet above. The sand and gravel may be many tens of feet in thickness and extend below the water table, so that dragline scrapers must be used to excavate below water level. Elsewhere in Ohio, very large operations below water level employ dredges, but it is unlikely that dredging will be used in Mahoning County until the easily accessible deposits are depleted.

Areas mapped as gravelly moraine and gravelly hummocky topography (pl. 1) as yet have not been explored for gravel. Within these areas are till-covered knolls that resemble kames. Some of these knolls may be buried Titusille(or older) kames. In Mahoning County and elsewhere in the Allegheny Plateau (White, Totten, and Gross, 1969; White, 1982) the best quality gravels are Titusville (or older) in age, and the possibility of finding additional good-quality gravel in Mahoning County is favorable. A drilling program will be required to assess the prospects of gravel in these hummocky areas where gravel is not exposed.

GROUND WATER

Ground water is another valuable natural resource of Mahoning County. Many municipalities, industries, and rural dwellers depend on wells for their water supply. Ground water generally is available everywhere, though in widely differing amounts and at various depths. Ground water in the county may be obtained in moderate to large quantities from two contrasting types of aquifers, the sandstone bedrock (Rau, 1969; Sedam, 1973) and the Pleistocene glaciofluvial sand and gravel deposits (Crowell, 1979).

Glacial deposits, particularly sand and gravel, are important aquifers where they have sufficient extent and thickness. Areas with the greatest potential yield of ground water are the preglacial and interglacial channels, which are now wholly or partially filled with glaciofluvial deposits of varying thickness.

In quarries and strip mines where the drift is thick, buried channels and gravelly lenses saturated with water (figs. 5, 8, 17) are commonly exposed. This water, although a nuisance in the mine or quarry, is a valuable resource if tapped by wells.

Another possible source of ground water is in the areas mapped as kames, kame terraces, and gravelly hummocky topography. These areas deserve to be considered for exploration, at least for wells for domestic water supply.

According to Crowell (1979), two small areas in Mahoning County have potential for sustained yields of ground water of 200 or more gallons per minute. One area is in the Mahoning River (west) valley in the southwestern corner of the county east of Alliance, where the aquifer is thick permeable sand and gravel. The other small area is in a portion of the valley of Crab Creek in northeast Youngstown north of the Mahoning River (east), where the aquifer is Pennsylvanian sandstone overlain by thick sand and gravel.

Crowell (1979) has identified several areas of Mahoning County that have the potential for yielding 25 to 100 gallons per minute of ground water. Six of these areas are in broad upland areas where Mississippian and Pennsylvanian sandstone aquifers are overlain by 30 to 40 feet of glacial drift. The largest area includes much of Coitsville Township in northeastern Mahoning County. Of great significance is the ground-water potential from buried valleys filled (partially or wholly) with 200 feet or more of permeable drift, mainly sand and gravel. Buried valleys with potential for yielding 25 to 100 gallons per minute of ground water include the Mahoning River valley (west) east of Alliance, the valley of Middle Fork Little Beaver Creek and its former northward extension into Ellsworth Township, the valley of Mill Creek (east) between Youngstown and the Mahoning-Columbiana County line, and the valley of the Mahoning River (east) and its tributaries Crab Creek and Dry Run. Other partially buried valleys in Mahoning County, including the valleys of Meander Creek, Mill Creek (west), Yellow Creek, and Honey Creek, contain lesser quantities of permeable drift and have lower potential ground-water yields of 10 to 25 gallons per minute (Crowell, 1979). In most upland areas of Mahoning County, according to Crowell (1979), ground-water yields of 10 to 25 gallons per minute, sufficient for most domestic or farm uses, are available from Mississippian and Pennsylvanian sandstones. According to Sedam (1973), some Pennsylvanian (Pottsville) sandstones in the southeastern part of the county contain salt water. Rau (1969) states that the Berea Sandstone of Mississippian age contains salt water below an elevation of 750 feet, which includes all of Mahoning County.

The Ohio Department of Natural Resources, Division of Water has on file much information which is available for examination by citizens. These data are useful as a basis for indicating areas of favorable possibilities.

PEAT

Peat, which for commercial use is commonly known as peat moss, forms by the accumulation of plants in a swamp or bog. Numerous poorly drained depressions and deeper kettle holes were left by the wasting ice sheets. These areas of standing water were sites of peat and silt accumulation until the bogs became filled or were drained. Nearly all bogs in Mahoning County are filled, although a few large, extremely swampy bogs contain standing water part of the year.

Dachnowski (1912, p. 94-99) mentions three bogs with known peat deposits in Mahoning County: Snyder Bog in secs. 24, 25, and 36, Beaver Township; Garfield Bog in secs. 30 and 31, Goshen Township; and New Albany Marsh in secs. 9 and 16, Green Township. Snyder Bog was the largest of the three, covering about 500 acres; borings (Dachnowski, 1912, p. 96) indicated good-quality peat in several layers to a depth of at least 17 feet. Only small areas of Snyder Bog remain today, as most of the original bog is covered by Pine Lake.

Peat occurs in numerous other localities, including the valley of Mill Creek (east) and the valley of Middle Fork Little Beaver Creek. As recently as 1984 a commercial peat-mining operation was located near Garfield Bog northwest of Damascus.

It is likely that peat from several localities in the county has found local use in farm gardens and in nurseries. All of the peat deposits examined in Mahoning County are thought to have accumulated since the disappearance of Hiram ice about 15,000 years ago.

GEOLOGY FOR PLANNING

The expansion of population and the growth of industry in Mahoning County have been accompanied by problems in land use. The realization that natural resources such as soil, water, minerals, forests, and even space for building sites are limited, exhaustible, and susceptible to pollution has led to increased emphasis on land-use planning.

Glacial deposits form the surficial materials nearly everywhere in the county, and the great variety of glacial materials influence suitability of the land for various uses. This report contains maps, descriptions, and diagrams to indicate what materials may be expected in various parts of Mahoning County. Not only is the material itself important, but its topographic position also must be carefully considered.

RESOURCES

SAND AND GRAVEL

The sand and gravel resources of Mahoning County are moderately extensive, although not as extensive as in some other counties on the Allegheny Plateau. The most favorable areas for developing commercial deposits of sand and gravel are the kames and kame terraces in the southern part of the county (pl. 1). Other possibly favorable sand and gravel areas are the kames and kame terraces in the central and northern parts, some valley trains, and the areas mapped as gravelly end moraine/hummocky topography. Thick overburden, which is costly and time consuming to move, may be a limitation, particularly in the gravelly hummocky areas. The lower portion of many gravel deposits is below the water table and dredging will be required if these gravels are to be utilized. Gravel deposits vary in quality both laterally and vertically and some gravels, particularly younger gravels, are not of suitable quality for use in concrete or asphalt.

The limited supply, coupled with the great demand in northeastern Ohio, manifests that conservation of sand and gravel resources should receive priority in planning; zoning regulations should protect the quarrying of these deposits, but at the same time should require that it be done in a planned way. In some parts of the county, regulations may be needed to protect the kame-terrace deposits from being engulfed by urban development. Areas underlain by gravel may be used for agriculture, woodland, or recreation until needed. At that point, a planned excavation procedure is essential in order to extract the maximum amount of sand and gravel with the minimum amount of disturbance and to provide return of the worked-out pits to agricultural, recreational, or other uses.

GROUND WATER

Underground sources provide water for the rural population of the county, and for some of the industrial and urban needs. Youngstown depends upon a series of surface reservoirs for its water needs. The major aquifers are the Pennsylvanian sandstones and the highly permeable Pleistocene sand and gravel deposits (kames, kame terraces, valley trains) along the major drainage lines. Sandy layers between tills, sandy lenses in tills, and the sandy Kent Till all contain water, in places in fairly large quantities. Valley trains may have the largest yields because of recharge from streams flowing through them. These glacial deposits have potential to provide significant amounts of additional water; however, because of their permeability and accessibility, they have a high susceptibility for pollution from waste disposal and agricultural or urban activity. Because ground-water supplies in Mahoning County are not widely distributed, it should be realized that certain areas are less promising than others.

PEAT

Peat deposits are a resource of possible value. The water table is at or near the surface in most peat bogs and this must be taken into account in planning excavation of peat. Some of the excavation problems must be overcome before the full potential of peat as a mineral resource can be realized. The undrained depressions or bogs in which peat deposits collect do not make suitable industrial or home sites, and conflicts in land use are likely to be less critical than for sand and gravel deposits.

Favorable areas for peat include kettle holes and ponded areas of partially buried valleys, mapped as lake deposits on plate 1. Most lake deposits, however, are silty or clayey and therefore not suitable as peat resources. Some areas mapped as valley trains may be underlain by peat.

WASTE DISPOSAL

Disposal of solid waste in landfills has special requirements for satisfactory sites (Hughes, Landon, and Farvolden, 1971; Groenewold, 1974). Considerations include permeability and porosity of the material and position of the water table. If other requirements are met, clayey Hiram Till and silty Lavery Till may be quite satisfactory for landfill sites (see fig. 15 for distribution of tills). The clayey Hiram Till may present a problem in that it is sticky when wet, rock hard when dry, and difficult to excavate under both conditions. Also, it must be kept in mind that in a landfill site, more than one till unit is likely to be present, and the units may be separated by silt or sand layers of varying thicknesses, as illustrated in figures 4, 5, 8, 9, 14, and 21. Even if a silt layer is so thin it is inconspicuous, or even appears to be absent, the interface between the tills may allow water movement, and leachate from a landfill may travel along this interface, as well as along a more evident porous sand or silt layer (White, 1972, p. 80).

Glacial materials are used in many places for the disposal of liquid wastes, commonly in tile fields for septic tanks. Tile fields in areas of clayey Hiram Till are necessarily sited in material of low permeability and very slow percolation. For satisfactory performance of the septic system, large tile fields must be provided. In some till areas, and in many topographically low areas, the water table is high for part of the year and serious problems may arise. In spite of low intergranular permeability, some effluent may travel along joints or along interfaces between tills and contaminate ground water. In areas of sand and gravel, percolation may be rapid and effluent may travel a considerable distance and contaminate ground water. It is evident that a knowledge both of the geology of a region and of the particular site is necessary for specification of proper equipment and installation.

EXCAVATIONS AND FOUNDATIONS

As larger and larger structures are built, foundation design becomes ever more important, and excavations become deeper and deeper. Such construction projects require a detailed study of the materials ("soils" in engineering terminology). This report indicates what materials may be expected in various parts of Mahoning County. However, for project planning and specifications, a detailed geological engineering study of each site is necessary. In such a study the multiple character of till deposits must be kept in mind in subsurface exploration. Figures 7, 9, 14, 17, 19, 20, and 21 illustrate the vertical and horizontal changes in glacial deposits. Water-bearing sand and gravel masses may thicken markedly in buried valleys (see figs. 4 and 5) and create slumping conditions. Thick sand masses may present severe water problems and may also present problems of differing materials with different properties across the area of the foundation.

On cut slopes, different tills may have different slope-stability angles. Water escaping from interfaces may cause piping at the slope, and actual cavities may be produced internally at some distance from the slope.

In planning for sources of fill it must be realized that the planned borrow pit may start in one material and at some depth encounter quite a different material. Even if the pit is entirely in till, the different tills may have differing compacting characteristics.

FLOODPLAINS

Floodplains present well-known constraints. By definition, a floodplain is covered by flood water of the stream. Low floodplains may be flooded more than once in some years, higher ones less often. The low terraces—second bottoms—along some streams are generally a few feet higher than the floodplain and are flooded only occasionally, sometimes not for several years. A false sense of security is engendered, but sooner or later a particularly high flood will inundate this part of the valley. Topographic maps and soil maps differentiate the floodplains and second bottoms. Detailed studies of flood heights and frequencies for the Mahoning River and Crab Creek have been made by the U.S. Army Corps of Engineers (1972).

Floodplains have excellent potential for recreation and wildlife but are not suitable for housing developments or other structures prone to flood damage.

RECREATION

In the future, as the population of northeastern Ohio increases and as a proportionally greater expanse of land is used for urban development, recreational land is almost certain to become a high-priority item. With increased leisure time becoming available, additional facilities for camping, hiking, picnicking, and other outdoor recreational activities will be required.

Mahoning County presently contains several significant recreational areas, including Berlin Reservoir, Lake Milton, Meander Creek Reservoir, and Mill Creek (east). Possible areas for future recreational land and facilities include strip-mined land and quarries, such as the valley of Honey Creek.

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Joseph J. Sommer, Director
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 139
GLACIAL GEOLOGY OF MAHONING COUNTY, OHIO

GLACIAL GEOLOGY OF MAHONING COUNTY, OHIO

by Stanley M. Totten
and
George W. White

1987

QUATERNARY

Recent

cf

Made land. Areas of excavation or filling, where land surface has been modified by man; includes strip-mined areas. Some areas of made land may be more extensive than shown on this map because of activity since the map was compiled

al

Alluvium. Generally silty deposits in stream channels and on flood-plains. Material highly variable; includes some poorly sorted sand and gravel

Pleistocene

Wisconsinan (Woodfordian)

Wl

Lake deposits. Mainly silt, clay, muck, and peat in kettle holes, on broad valley flats, and in shallow depressions on uplands

Wo

Outwash. Gravel and sand in valley trains and terrace remnants of dissected valley trains

Wk

Kames and kame terraces. Mainly sand and gravel. Overlain by till in many places

g

Ground moraine. Till in smooth to gently undulating surface on drift-veneered bedrock hills

e

End moraine. Till in distinct belts of short ridgelike segments and low hummocks several feet to 30 feet high, primarily in southern half of county. Areas of end moraine containing gravel masses shown by overprint; these may be in part buried kames or kame terraces

h

Hummocky topography. Till in thicker accumulations that exhibit an undulating or knoll-like surface, primarily along major valleys in northern part of county. Areas of hummocky topography containing gravel masses shown by overprint; these may be in part buried kames or kame terraces

Whg | Whe | Whh

Hiram Till. Silty clayey till, generally 1 to 10 feet thick. Whg, Hiram ground moraine; Whe, Hiram end moraine draped over earlier moraine; Whh, Hiram Till draped over earlier hummocky topography

Wlg | Wle | Wlh

Lavery Till. Silty till, 3 to 10 feet thick in thicker phase; discontinuous and in widely scattered patches rarely more than 3 feet thick in outer margin. Kent Till is at the surface in much of the outer margin. Wlg, Lavery ground moraine; Wle, Lavery end moraine draped over earlier moraine; Wlh, Lavery Till draped over earlier hummocky topography

Wkg | Wke

Kent Till. Sandy till, generally less than 7 feet thick; may be so thin that underlying Titusville Till is exposed in road cuts and excavations. Wkg, Kent ground moraine; Wke, Kent end moraine draped over earlier moraine

Boundary of deposit, dashed where approximate

Approximate boundary of Hiram Till

Approximate boundary of Lavery Till

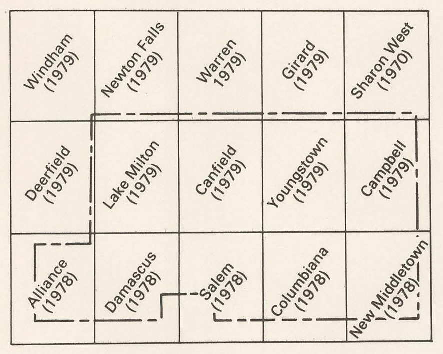
Approximate boundary of thicker, more continuous Lavery Till

800 Contour on bedrock surface, contour interval 50 feet

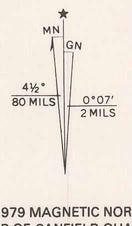
Gravel pit, active

Gravel pit, small or abandoned

Note: Steep valley walls, which may be in part bedrock, have been included with contiguous glacial material



1:24,000 U.S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLE MAPS COVERING MAHONING COUNTY (DATES IN PARENTHESES INDICATE DATE OF NEGATIVES USED TO COMPILE BASE)



UTM GRID AND 1979 MAGNETIC NORTH DECLINATION AT CENTER OF CANFIELD QUADRANGLE

10,000-foot grid based on Ohio coordinate system, north zone

1927 North American datum

LOCATION MAP

1 0 1 2 miles

1 0 1 2 kilometers

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

CONTOURS ON BEDROCK SURFACE BY JOEL D. VORMELKER

JAMES A BROWN, CARTOGRAPHER